The Reptiles and Amphibians of Dhofar, Southern Arabia

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CONTENTS

Summary. Some 500 Dhofar reptiles and amphibians are discussed and a minimum of 48 terrestrial species recognised for the area of which 5 were previously undescribed; these are a gecko, *Hemidactylus lemurinus*, and the lacertids *Acanthodactylus felicis*, *A. opheodurus*, *A. masirae* and *Mesalina ayunensis*; a new subspecies of gecko from north Oman, *Bunopus spatalurus hajarensis* is also reported. Various other species are reviewed: it appears that *Bunopus abudhabi* is a synonym of *B. blanfordii* which is probably conspecific with *B. tuberculatus*; *Hemidactylus parkeri* is regarded as a subspecies of *H. turcicus*; the Arabian agamas of the *Agama cyanogaster* group are shown to include 2 species to which the names *adramitana* and *yemenensis* are applicable although their status relative to African populations in the group is not clear; *A. jayakari* is conspecific with *A. flavimaculata*, and *A. neumanni* with *A. sinaita*; *Chamaeleo chamaeleon orientalis* is similar to more northern populations of *C. chamaeleon* but *C. c. arabicus* is very well differentiated and may be a separate species; the use of genitalia in the classification of *Acanthodactylus* is emphasised and *A. arabicus*, *A. blanfordii* and *A. schmidti* are all given full species status; the recognition of *Mesalina* as a genus independent of *Eremias* is confirmed; it is suggested that *Atractaspis engeddensis* may be conspecific with *A. microlepidota* and that *Lytorhynchus gaddi* is a synonym of *L. diadema*; the distinctive population of *Echis carinatus* in Dhofar appears to be closely related to those in south-west Arabia and adjoining Africa but animals from northern Oman and the rest of south-west Asia are very different. Additional specimens are reported of *Bunopus s. spatalurus* and *Coluber thomasi*, both previously known from only 2 individuals. Geographical variation of a number of species is described including 3 geckoes that show very considerable differences within southern Dhofar: *Hemidactylus homoeolepis*, *H. yerburii* and *Tropiocolotes scorteccii*.

Observations on the ecology of many species are noted, especially for the aberrant gecko genus *Pristurus*, one species of which, *P. carteri*, behaves like a small, ground-dwelling diurnal agamid. Resource partition, at least amongst the lizards, appears to be

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largely based on parameters of time, food (especially prey size), hunting method and space. A number of forms occurring in both north Oman and Dhofar show differences in niche in the two areas apparently related to the presence or absence of a competitor.

Several species are recorded from Dhofar for the first time including *Bunopus spatalurus*, *Hemidactylus flaviviridis*, *H. turcicus parkeri*, *Pristurus minimus*, *Agama adramitana*, *Acanthodactylus boskianus*, *Mabuya tessellata*, *Leptotyphlops macrorhynchus* and *Lytorhynchus diadema*. The herpetofauna of the area can be divided into a largely northern element of desert-adapted forms widespread in the Arabian peninsula and a more peripheral element in the south which shows considerably more affinity to south-west Arabia than to northern Oman. No reptile or amphibian endemics occur in the forested areas of Dhofar but 3 species present in the dry-mesic habitats on the north side of the mountains may be restricted to the region.

Introduction

Dhofar is the southernmost province of the Sultanate of Oman and lies on the south-east coast of Arabia. It is bordered to the north-west by Saudi Arabia, to the south-west by South Yemen and to the south-east by the Arabian Sea; the north-eastern and eastern perimeters of the area covered by this paper, which is rather more extensive than Dhofar province proper, are 20°N and 57°E. The region so delimited extends along the coast for some 600 km and inland for about 250 km. It includes a wide variety of climatic conditions and plant communities, although as yet there is no formal classification of habitat types in the area (but see Sale, 1980, this volume, for broad ecological zones). In the south-west, mountains run parallel to the coast forming the last part of the high country that extends fairly continuously along the south Arabian seaboard from Yemen. From west to east, the Dhofar mountains are Jabal Qamr (1,460 m), Jabal Qara (1,050 m) and Jabal Samhan (2,030 m). The seaward faces of the first two, together with a small adjoining part of Jabal Samhan and the alluvial plain between Jabal Qara and the sea on which the town of Salalah stands, form the main region of the south Arabian coast to receive substantial moisture from the south-west monsoon. From mid-June to mid-September the steep seaward slopes of these mountains are largely hidden by dense mist and drizzle is frequent. This enables the small area concerned to support much more abundant vegetation than the surrounding country and there are quite extensive stands of dense forest. Although dry for much of the year, the land touched by the monsoon becomes covered by a flush of luxuriant foliage which persists for some time afterwards. On the crests of the forested mountains this takes the form of a near monoculture of high grass (*Themeda*) amongst which are scattered large trees, but this park-like community is almost certainly an artefact resulting from extensive cattle grazing and perhaps tree felling as well. Inland the country slopes gently downwards towards the Arabian Gulf nearly 800 km away. The inland face of the mountains is much drier than the seaward side but supports appreciable amounts of scattered vegetation including frankincense trees (*Boswellia*). Further north the country becomes increasingly arid and barren gravel areas are eventually succeeded by the sands and *sabkha* (salt flats) that border the great Rub' al Khali desert. North-east of the mountains the arid habitats approach and in some cases contact the coast. So, essentially, there is in Dhofar a relatively mesic area associated with the mountains that can be divided into the intermittently moist seaward region and a drier landward one, and a series of increasingly arid environments lying to the north and east of the mesic area.

The reptiles and amphibians of Dhofar have always been of great potential interest. Material from the province would bridge the long gap between the better collected areas of south-west Arabia and north Oman and, given the relatively moist climate of south Dhofar, there was the possibility that relict forms might have survived there from a period when more mesic conditions were wider spread in Arabia. But until recently the herpetofauna of the region has been very poorly known. The first specimens to reach a museum were three chameleons sent to the British Museum (Natural History) by A. S. G. Jayakar in 1898. Nothing else seems to have been obtained until Bertram Thomas made his two inland journeys from Salalah. In early 1930 he travelled with his secretary Ali Muhammad, to Ramlat Mugshin on the edge of the Rub' al Khali and late that year he collected around Salalah and in the Dhofar mountains before setting out in early 1931 to cross the Rub' al Khali to Qatar (Thomas, 1931a; 1931b; 1932). His material consequently contains specimens from both the mesic and desert areas of the province and includes twenty-seven species, a number of which were described as new forms by H. W. Parker (1930; 1931), namely *Bufo dhufarensis*, *Pristurus carteri tuberculatus*, *Ceramodactylus major* (= *Stenodactylus doriae*), *Uromastyx thomasi* and *Coluber thomasi*. After Thomas there was a hiatus of forty years but in the early 1970s people whose employment took them to Dhofar during the emer-

gency produced a scattering of specimens and more substantial collections were made by T. D. Rogers and S. Moult (in 1975) and especially M. D. Gallagher (in 1976–8). In 1977 the Oman Flora and Fauna Survey, organised by the Ministry of Diwan Affairs, visited south-west Dhofar and included the writer among its participants. Some 350 reptiles and amphibians were collected, bringing the total number of terrestrial species known from Dhofar to forty-eight. In the following account all the approximately 500 specimens available from Dhofar are reviewed and, where possible, information about ecology and behaviour is given, being largely based on observations made during the 1977 Survey. Unless otherwise indicated statements are based on material in the British Museum (Natural History), London.

SPECIMEN DATA

Locality

To save repetition, collecting sites which are mentioned more than two or three times are listed below with co-ordinates for those that cannot be found on the attached map. However, in the case of some of Thomas' localities around Jabal Qara, precise positions have not been determined.

Ain Arzat (Ain al Rizat)
Arzat
Ayun
Bir ba Shu'aythan, 18°22′N 55°10′E, 230 m
Bin Juay (= Ju'ai), 17°38′N 54°00′E
Bin Khautar, 19°16′N 54°23′E, 720 ft. (220 m)
Dauqa, 18°40′N 54°04′E
Haylat Ash Shisur, 18°17′N 53°32′E, 1,080 ft. (330 m)
Jabal Qamr (Qamar)
Jabal Qara
Jabal Samhan
Khadrafi
Khawr (Khor) Sawli, 17°03′N 54°20′E
Milwah al Aud (Milwah Alaud) 220 ft. (70 m), near Ain Arzat
Ramlat Shu'ait, 18°48′N 52°12′E, 1,000 ft. (310 m)
Raysut (Rayzut)
Salalah
Thamarit (Thumrait)
Wadi Darbat
Wadi Haluf
Wadi Raykhut
Wadi Sarfait
Wadi Sayq

Accession numbers

In nearly all cases material discussed is deposited in the British Museum (Natural History), London; accession numbers for this institution are given the prefix BM.

Collectors

Material obtained during the course of the Oman Flora and Fauna Survey 1977 was collected largely but by no means entirely by the writer and bears no special indication where listed. The names of two frequently mentioned collectors are abbreviated to save space: Bertram Thomas (BT) and Michael Gallagher (MDG). The names of all others who have presented specimens are given in full.

Sex and status

In most cases, sex of specimens is given except for some individuals which are juvenile (juv.). However for one or two species, especially where determination of sex is arduous, these data have been omitted.

Scale counts

For some snakes, three standard scale counts are given: D is transverse count of dorsal scales midway between snout tip and vent, V is number of ventrals counted by the Dowling method (Dowling, 1951) and C is number of subcaudal scales.

Systematic List

Class AMPHIBIA
Order SALIENTIA
Family BUFONIDAE: typical toads

Bufo dhufarensis Parker

Bufo dhufarensis Parker, 1931: 518. Type locality: Milwah al Aud, 220 ft. (70 m) Dhofar.

DISTRIBUTION. Peripheral Arabia from Mecca south to South Yemen and thence east to northern Oman.

MATERIAL. Milwah al Aud, 220 ft. (70 m): BM 1931.7.16. 1/1947.2.21.66, (BT), ♀, holotype. Wadi Sayq: BM 1977.910, 1 juv. Khadrafi plateau: BM 1977.898, 1 juv. Salalah: BM 1975.1375–76, (T. D. ROGERS), BM 1977.25, (MDG), BM 1977.886–91. Ain Arzat: BM 1976.1382–83, (S. MOULT/MDG). Khawr Sawli: BM 1977.892–93. Jabal Qara, E of Salalah–Thamarit road, 2,800 ft. (860 m): BM 1977.908–09. 33 km along Thamarit road from Salalah, 1,700 ft. (520 m): BM 1977.906–07. Wadi Ayun

pool: BM 1977.903–05. 16 km S of Thamarit: BM 1977.894. Wadi Darbat: BM 1977.899–902. Wadi Raykhut: BM 1977.895–97. Sight records also from Wadi Jarziz and Dhahariz.

Arabia has a very sparse amphibian fauna which is distributed mainly around the edge of the peninsula, being apparently absent from much of the dry centre. As might be expected, the richest area is the comparatively moist south-west where all recorded species of Arabian amphibians are present. Besides *B. dhufarensis* these are *Hyla* (*arborea*) *savignyi*[1] Audouin, 1812 (Asir and Yemen), *Rana cyanophlictis ehrenbergii* Peters, 1864 (south-west Saudi Arabia to Hadhramaut), *Rana ridibunda* Pallas, 1771 (Asir, Yemen, Bahrain, north-east Saudi Arabia as far south as Hofuf), *Bufo orientalis* Werner, 1895 (south-west Saudi Arabia to Hadhramaut; north Oman), *B. hadramutinus* Cherchi, 1963 (Hadhramaut, closely related to *B. orientalis*), *B. scorteccii* Balletto & Cherchi, 1970 (Yemen, very similar to *B. dhufarensis*), *B. pentoni tihamicus* Balletto & Cherchi, 1973 (coastal south-west Saudi Arabia, North Yemen and western South Yemen) and *Bufo viridis* Laurenti, 1768 (Jabal Sawdah in Asir, Saudi Arabia, BM 1977.384–92, recently collected by C. H. Lowe). *Bufo regularis* Reuss, 1834 (type locality: Egypt) has also been recorded from south-west Arabia (see for instance Parker, 1938) but specimens so assigned are very similar to *B. orientalis*. It is possible that the two species are closely related, perhaps even conspecific. Of these species *Hyla* (*a.*) *savignyi*, *Rana ridibunda* and *Bufo viridis* have their main populations to the north of Arabia while *Bufo pentoni* and *Rana cyanophlictis* have other subspecies in north Africa and south-west Asia respectively but the affinities of the apparently endemic *Bufo dhufarensis* are uncertain.

In spite of relatively heavy rainfall in the south, Dhofar appears to have only one amphibian species, *Bufo dhufarensis*. This shows little overt geographical differentiation but Dhofar animals are quite variable in colour, being most frequently brown or olive but some juveniles are distinctly green. This toad occupies a very wide range of habitats from sea level to at least 860 m and probably higher. It is often very abundant near water, either close to the sea or in irrigated areas and wet wadis. Here it is common in grass and other vegetation and around piles of litter (banana leaves *etc.*) and is often active by day as well as night in shaded places, although it does not enter water much. *B. dhufarensis* is frequently encountered sitting on top of low rocks and at Wadi Raykhut individuals climbed 1.5 m up a sloping *Acacia* trunk at night to feed on insects attracted to a lamp. Toads were also found well away from open water on the gravelly floors of wadis, in the grassland on the crest of Jabal Qara and on sandy and stony surfaces in semi-desert. In hot and arid habitats they were active only at night and were far less abundant than near water.

In the eastern United Arab Emirates, non-breeding adults of this toad are usually encountered at night on gravelly plains and appear to be excluded from wet wadis and irrigated areas by the partly diurnal *B. orientalis*. Their presence in such habitats in Dhofar is probably due to the absence of the latter species but, although *B. dhufarensis* occupies this niche, it appears to do so less effectively, not being so active by day or swimming so readily or so well.

In Dhofar breeding appears to take place during the monsoon, that is between June and early September (T. D. Rogers, pers. comm.). No spawn or tadpoles were seen in late September and October 1977, but many small toads in the 2–3 cm size range were about, suggesting recent breeding. In northern Oman, spawning has been recorded in March and May.

Class REPTILIA
Order SQUAMATA
Suborder SAURIA
Family GEKKONIDAE: geckoes

Bunopus spatalurus spatalurus Anderson (*Plate 1*)

Bunopus spatalurus Anderson 1901: 137. Type locality: Wadi Jimil, near Aden.

DISTRIBUTION. South Arabia, from Aden to Dhofar.

MATERIAL. 16 km S of Thamarit: BM 1978.1095, 1 ♀.

B. spatalurus is known from single specimens collected near Aden (holotype), north of the Hadhramaut (type of *Trachydactylus jolensis* Haas & Battersby, 1959) and now Dhofar; as well as these, there are many examples from numerous localities in the eastern United Arab Emirates and northern Oman south to Masirah. The Dhofar animal is very like the two more western specimens but the northern Oman populations differ in their smaller size and strongly keeled dorsals. As the type facies is apparently constant over nearly 1,100 km

and that in northern Oman over 700 km it seems probable that any transition between them, if they are continuous, is likely to be relatively abrupt. In these circumstances, it is reasonable to name the two entities as subspecies, and the northern Oman race is formally described below.

The one *B. spatalurus* encountered in Dhofar was caught at night walking slowly on extended legs down an extremely rough sloping rock surface (a portion is visible in Pl. 1) on a small and abrupt hill in flat, stony country. No other specimens were found in spite of extensive searching and the collector of the Hadhramaut example (G. Popov) had a similar experience (Haas & Battesby, 1959). This contrasts with the situation in northern Oman where *B. spatalurus* is relatively abundant, especially on gravelly plains and slopes (Arnold & Gallagher, 1977). In Dhofar, structurally similar habitats are occupied by *Pristurus carteri* and it may well be competition from this species, which does not occur in northern Oman, that restricts *B. spatalurus* in the south of its range.

Bunopus spatalurus hajarensis ssp. nov.

(Plate 1, Arnold & Gallagher, 1977)

ORIGIN OF NAME. From the Hajar mountains of northern Oman on which the distribution of this form is centred.

DISTRIBUTION. Eastern United Arab Emirates, northern Oman south to Masirah.

MATERIAL. *Holotype.* Wadi Ham, Masafi (25°18½′N 56°10′E) United Arab Emirates: BM 1973.1801, (E. N. ARNOLD, 27.5.1973), ♀. *Paratypes.* 58 specimens listed by Arnold (1977: 87).

DIAGNOSIS. Differs from *B. s. spatalurus* in its smaller size (up to 50 mm from snout to vent compared with up to at least 67 mm) and strongly keeled dorsal scales.

DESCRIPTION OF HOLOTYPE. A female preserved initially in formalin and stored in alcohol. Fairly robust and not very depressed, neck well marked, limbs and tail slender. Head length about 30% of snout-vent distance, head width about $\frac{2}{3}$ of length, adpressed hind limb reaches neck, tail length about $\frac{4}{5}$ of head plus body.

Rostral scale rather less than twice as wide as high with a convex upper border and a median cleft extending nearly to lower border. Internasals separated by two scales; nostril situated between upper labial, rostral, internasal and three small postnasal scales. A distinct depression present in each anterior loreal region. Scales on snout juxtaposed, rather convex and keeled, somewhat enlarged in upper posterior loreal region. Twelve scales in a horizontal line between the postnasals and the anterior edge of the orbit, 17 scales across snout at level of third upper labials, 24 in a transverse row just in front of orbits, 14 in transverse row at level of mid-orbits. Top of head with more heterogeneous scaling than snout, consisting of small scales interspersed with larger, rounded ones that are convex and often keeled and biggest in the upper temporal area.

Eye large; diameter of spectacle $\frac{3}{5}$ of distance from its anterior edge to the snout tip; diameter of bony orbit from its anteroventral margin to the most lateral point of the postfrontal bone about $\frac{4}{5}$ of snout length. Palpebral fold strong, its outer face edged by large scales which decrease in size posteriorly and become ciliate, being separated from the edge of the supraorbital region by two rows of small scales. Pupil vertical with a scalloped edge and able to contract to four 'pinholes'. Upper temporal area with scattered keeled tubercles. Ear small, oval and smooth-edged, its longest axis running backwards and upwards and about $\frac{2}{5}$ of spectacle diameter. 15/14 enlarged upper labial scales (12/11 to point just below centre of eye); 11/11 lower labials (9/9 to a point just below centre of eye). Mental small, more or less wedge-shaped and obtusely pointed behind, extending backwards to the level of the middle of the second upper labials. A pair of enlarged scales, each situated laterally to the posterior section of the mental, in contact with the first upper labial, about $\frac{2}{5}$ the length of mental and separated from each other on mid-line by two gular scales. Gulars small, raised and granular, feebly enlarged where they border the lower labials.

Dorsum of neck and body with irregular, sometimes discontinuous, longitudinal rows of enlarged, blunt, flattish scales which vary in size and have a strong median keel that increases in height to the posterior border; about eight rows at mid-body and six between the hind legs. Scales between enlarged ones are smaller but generally similar in form; those on upper flank also small and keeled but less flattened and interspersed with a few larger ones. Ventrals about $1\frac{1}{2}$ times as long as central gulars, rounded behind with a blunt central keel, becoming smaller, more raised and unkeeled towards flanks. About 70 scales around mid-body.

Four enlarged, square, flat scales in a transverse row in front of vent and separated from it by about nine rows of smaller scales; enlarged scales twice as large as those bordering them and without obvious pores.

Forelimbs covered above by flat, obtusely pointed, imbricate, keeled scales that are larger proximally; scales beneath are granular, somewhat bigger than gulars and keeled under lower limbs which are surrounded by about 17 scale-rows. Digits laterally compressed distally, short and strongly angled, covered by small, imbricate, keeled scales above, and by broad lamellae below which bear pointed projections that are strongest on the distal edges; claws small and short.

Hind limb covered above by heterogeneous, imbricate, keeled scales similar in form to those on mid-back; scales beneath are small and slightly imbricate, smaller than the mid-ventral body scales on thigh and about the same size on the tibia where they are keeled. Digits similar to those on manus; 18/18 lamellae beneath fourth toe.

Tail cylindrical, gradually tapering with a rounded tip, made up of about 24 verticils, each comprising three whorls of scales the most distal of these being of large, strongly keeled and pointed scales dorsolaterally and laterally; whorl immediately anterior to this also shows some scale enlargement but remaining one is made up of small and flat scales although these are keeled on dorsum. Scales beneath tail regular, lightly keeled and becoming raised towards tail tip.

Colour in spirit. Dorsum a warm, light brown above. Snout dark with a light streak running obliquely upwards and backwards from the nasal area to the eye; anterior of palpebral fold conspicuously light; vague dark markings present on temporal region. A series of broad, dark brown transverse bands above: one on neck, three between pairs of limbs and one on sacrum, their posterior borders irregular. Ten bands on tail, each about as wide as the spaces between them; weaker bands also present on limbs. Body bands coalesce on flanks which bear lighter spots; underside dirty white; iris grey-brown with a darker veination.

Size. Snout to vent 45 mm; head length 14 mm; tail 38 mm.

PARATYPES. Generally similar to holotype: largest animals up to 50 mm from snout to vent, enlarged scales bordering mental posteriorly are often big and in contact in south of range. Males have well-defined femoral pores and the enlarged plates bearing them may number six. Pattern varies in intensity (partly as a result of physiological colour change). Shape of bands on back not constant and sometimes each is broken into three blotches; body bands do not always coalesce on flanks which may bear irregular markings; 8–12 bands on tail. Colour tends to be a richer brown in life.

Bunopus tuberculatus Blanford s. lat.

Bunopus tuberculatus Blanford, 1874a: 454. Type locality: 'in Gedrosia Persiaque' (types from Baku Kalat, Bampur and Mand, Baluchistan).

Bunopus blanfordii Strauch, 1887: 61. Type locality: Egypt.

Bunopus abudhabi Leviton & Anderson, 1967: 164. Type locality: near 23°45′N 53°35′E, Abu Dhabi.

DISTRIBUTION. Palestine, Jordan, south Iraq, Arabia, Iran, Afghanistan and Pakistan. The types of *B. blanfordii* allegedly come from Egypt but no *Bunopus* has been encountered there since.

MATERIAL. Shisr (18°15′N 53°40′E): BM 1978.330, (MDG), 1 ♀. Bin Khautar: BM 1930.6.30.4, (BT), 1 juv. Burza (19°25′N 54°25′E): (MDG), 1 ♂. Khalil: BM 1976. 1397, (MDG), 1 juv.

All three nominal forms of *Bunopus* listed above have been recorded from Arabia but examination of over 180 animals from more than forty localities suggests only a single species is present. This shows considerable variation in a range of features. In the west, animals tend to be slender with large dorsal tubercles and low femoral pore counts in males (often under 8 compared with 8–21 elsewhere). Presence or absence of keeling on the ventrals and degree of carination on the subdigital lamellae vary rather irregularly but presence of expanded subcaudal plates is apparently restricted to an area from Hadhramaut and parts of Dhofar across the Rub' al Khali desert to eastern Abu Dhabi in the United Arab Emirates. All these characters vary substantially within populations, for instance, development of expanded subcaudals may involve nearly all the tail in some individuals where it occurs but in others it is limited to the tail tip or completely absent. The type of *B. blanfordii* is most similar to specimens from the west, from Yemen to Palestine, and probably originated in this general area. *B. abudhabi* is said to differ from *B. blanfordii* in its more robust habitus, keeled ventrals and expanded sub-

caudals, features which are certainly common in the area of the type locality in eastern Abu Dhabi but this population grades into others which are more like typical *B. blanfordii*.

It is still not absolutely certain if the Arabian populations are conspecific with *B. tuberculatus* of Pakistan, Afghanistan and Iran. Here animals tend to be stockier with smaller, less strongly keeled dorsal tubercles and shorter toes but again there is substantial variation and it seems very likely that *B. blanfordii*, including *B. abudhabi* should be placed in the synonomy of *B. tuberculatus*.

In the eastern United Arab Emirates, this gecko is ground dwelling and active after dusk on a variety of sandy substrates ranging from quite hard consolidated surfaces such as sandy sabkha and fossil dunes to loose aeolian sand. In the latter habitat, it tends to be seen close to vegetation whereas *Stenodactylus doriae* and *S. arabicus* occur especially in the open areas between plants. Body temperatures of nineteen animals active after dusk were in the range 26–34°C. Five of the higher temperatures were well above those of the open ground surface (28.5, 28.5, 30, 32.5, and 34°C compared with 23.5, 24, 28, 28 and 26°C respectively). This phenomenon was not encountered in other geckoes and seems to result from *Bunopus tuberculatus* using heat stored in the ground. In desert regions where surfaces receive much insolation during the day but have high radiation rates at night, there is often a reversal in the soil temperature gradient beginning late in the afternoon, so that after dusk temperatures at depths of a few centimetres are considerably higher than those at the surface. For instance at Sharjah on 30 April 1973, temperatures at the sand surface and at 10 cm depth were respectively 34 and 36°C at sunset, 29 and 35°C two hours later and 24 and 34°C after four hours. *B. tuberculatus* appears to utilise this ground heat through burrows. Three of the five animals with high temperatures were caught very near to or actually in the entrances of rodent holes and it is probable that they absorbed ground heat either by descending below surface level or from draughts of warm air coming out of the burrows. This gecko seems to select warm microhabitats in the day as well. Six animals excavated from burrows were all in sections of tunnel very close to the sun-warmed surface and in two cases were beneath thin pieces of wood. Their temperatures were 33.4, 35.5, 35.5, 36.5, 37 and 37°C, much higher than the air temperature at lower levels in the burrow.

Hemidactylus flaviviridis Rüppell

Hemidactylus flaviviridis Rüppell, 1835: 18. Type locality: Massaua (= Massawa, Eritrea).

DISTRIBUTION. Coastal areas of Red Sea, Somalia and Arabia; Iraq, southern Iran, Pakistan and northern India.

This quite large gecko is widely distributed around the coasts of Arabia being known from Jeddah, Aden, Muscat, Ras al Khaimah, Sharjah, Dubai and Bahrain where it is often associated with buildings. Although no examples were captured in Dhofar some geckoes that appeared to be of this species were seen on the outside walls of well-established buildings in the town of Salalah shortly before dusk and afterwards in the vicinity of shop lights. Most animals observed were more than 2 m from the ground.

Hemidactylus homoeolepis Blanford *(Plates 2–3)*

Hemidactylus (*Liurus*) *homoeolepis* Blanford, 1881: 464. Type locality: Socotra.

DISTRIBUTION. Socotra; extreme southern Arabia from Shugra to Masirah.

MATERIAL. Wadi Sayq: BM 1977.919–925, 2 ♂♂, 3 ♀♀, 2 juv. Ayun: BM 1977.911–17, BM 1978.331, 3 ♂♂, 3 ♀♀, 2 juv. 7 km E of Ayun: BM 1977.926–28, 3 juv. 16 km S of Thamarit: BM 1977.918, 1 ♂. Arzat: BM 1976.1401, (MDG), 1 juv. Khawr Sawli: BM 1977.929–944, 4 ♂♂, 11 ♀♀, 1 juv. Hasikaya, Kuria Muria Islands: BM 1974.4051, 1 ♂.

Variation in samples assigned to *H. homoeolepis* is summarised in Table 1. It will be seen that, as reported previously (Arnold, 1977), there is substantial geographical variation and this applies even within Dhofar. Animals from Wadi Sayq, Ayun and Thamarit have homogeneous scaling and the continuous row of enlarged subcaudal scales begins about a head length behind the vent. In contrast, animals from Salalah plain (Arzat, Khawr Sawli) have enlarged tubercles on the tail base and hind legs and often, although not always, on the flanks as well and the row of enlarged subcaudals reaches further forwards, often almost to the vent. This difference is considerable, especially as Ayun and Arzat are only about 40 km apart; possibly the intervening heavily vegetated areas of Jabal Qara act as a barrier preventing contact between the two forms. The differences between some of the known populations

TABLE 1. Geographical variation in *Hemidactylus homoeolepis*

	Shugra, South Yemen	Socotra	Wadi Sayq, Ayun, Thamarit	Khawr Sawli, Arzat	Hasikiya	Masirah
n	1	17	19	17	1	7
enlarged tubercles on body	no	occasionally on hind back	no	in some cases on hind back	on hind back	yes
tail-base	yes	occasionally	no	yes	yes	yes
legs	yes	occasionally	no	yes	yes	yes
row of enlarged subcaudal scales extends almost to tail-base	?	no	no	yes	yes	yes
upper posterior loreal scales rather flattened	no	no	no	no	yes	yes
head markedly depressed	no	no	no	no	yes	yes
maximum snout to vent length (mm)	36	41	33	39	32	46
number of scansors on hind toe 1	4	(4)5	4–5	4–5	5	6
3	7	(7)8	7–8	7–8	8	9–10
4	8	9–10	7–9	7–9	9	10–11

regarded here as belonging to *H. homoeolepis* are greater than those between some recognised species of *Hemidactylus* but premature application of formal names is unlikely to clarify this complex pattern of variation and it seems best to wait until more material is collected from areas between the localities of the samples now available.

H. homoeolepis is abundant at many sites in Dhofar. It is a small nocturnal gecko found in usually dry places on rocky surfaces near the ground and on sandy and stony substrates close by. At Khawr Sawli it occurs on rock outcrops and on the ground surrounding them, at Ayun it occupies stony ground and sloping rock pavements and at Thamarit was found on screes of small stones. At these localities 62% of sixty-four animals checked were first sighted on the ground and all but one of the others were no higher than 60 cm from it. At Wadi Sayq, eighteen individuals seen were at heights of between 50 cm and 2 m on rock faces, but this may have been because the ground here was covered by dense vegetation following the monsoon. *H. homoeolepis* is very agile, often proceeding in a series of leaps when pursued. A number of females from Khawr Sawli were gravid in late September, each bearing a single egg that was visible through the translucent skin.

Hemidactylus lemurinus sp. nov. (*Plates 4–5*)

ORIGIN OF NAME. From the Latin *lemures*, ghosts or spectres.

DISTRIBUTION. Known only from Dhofar, Sultanate of Oman.

MATERIAL. *Holotype*. Ayun: BM 1977.986, (E. N. ARNOLD), ♂. *Paratypes*. Ayun: BM 1977.987–1002, (E. N. ARNOLD), ♂♂, ♀♀, juvs.

DIAGNOSIS. A medium-sized species of *Hemidactylus* (up to 68 mm from snout to vent) with slender limbs and a relatively slender, evenly tapered, scarcely depressed tail (about as long as head plus body in adults), very fine scaling without enlarged tubercles, two pairs of postmentals, the more median being the larger but not more than ¾ length of mental, 4–8 preanal pores in both sexes, large adhesive pads on digits with 6–7 lamellae beneath first hind toe, 10–11 beneath third and 11–12 beneath fourth, a row of expanded subcaudal scales extending forwards almost to tail base and pale colouring often involving a weak pattern of rather darker transverse bars.

Amongst the *Hemidactylus* of Arabia and neighbouring areas, superficially most similar to *H. flaviviridis* but snout shorter and broader, limbs more slender, tail

thinner, not strongly flattened and without tubercles or clearly defined verticils, postmentals shorter, preanal pores present instead of femoral ones and distal sections of digits shorter. Other *Hemidactylus* in the region with more or less homogeneous scaling (*e.g. H. laevis, H. megalops*, some *H. homoeolepis* populations, *H. oxyrhinus*) are all small with small digital pads and differ in several other features.

DESCRIPTION OF HOLOTYPE. A mature male preserved initially with formalin and stored in alcohol. Two shot holes in left flank, a dust shot pellet beneath skin on dorsum to right of mid-line, two tears in skin over tail-base and minor ones elsewhere.

A relatively slender *Hemidactylus* with a broad, depressed head, bulging cheeks, a short, broad and flattened snout and rather long limbs. Head length (from snout to posterior edge of supratemporal bone located without breaking skin) about $1\frac{2}{3}$ width at posterior tips of maxillae, $1\frac{2}{5}$ width at quadrates and about 30% of snout-vent distance; head depth about 60% of width. Adpressed forelimb extends beyond snout tip, adpressed hind limb reaches axilla. Tail slightly depressed at base but more rounded distally with an even taper; about as long as the snout-vent distance.

Rostral scale about $1\frac{1}{3}$ times as broad as high with a complexly indented upper margin, a slight median depression above, and a medial cleft extending downwards over half way to the lower border. Internasals somewhat enlarged and separated on mid-line by a single scale. Nostril situated between rostral, internasal and two postnasal scales, the first upper labial also entering very narrowly into border of right nostril. A distinct depression in each anterior loreal region and another more pronounced, lanceolate one on the mid-line just anterior to eyes. Scales on dorsum of head all granular and juxtaposed, those on snout mostly about $1\frac{1}{2}$ times as large as on occiput but three times as large in upper loreal region. About 15 scales from the postnasals to the bony edge of the orbit, 29 scales across snout at the level of the third upper labials, 47 just in front of orbits and 36 in a transverse row at mid-orbits.

Eye very large: diameter of spectacle nearly $\frac{2}{3}$ distance from its anterior edge to snout tip; diameter of bony orbit, from its anteroventral margin to the most lateral point of postfrontal bone, more than length of snout. Palpebral fold with a row of enlarged scales on its outer face that are largest anterodorsally, posterodorsally a few ciliate scales project from beneath fold. Pupil vertical with a scalloped edge, able to contract to four 'pinholes'. Ear-hole a narrow elipse, its longest axis running backwards and upwards and somewhat less than a third of the spectacle diameter.

11/10 upper labials, 8 to a point just below centre of eye; 8/8 lower labials, the last very small; labials decrease in size posteriorly. Mental large, wedge-shaped, extending backwards beyond the level of the suture between the first and second lower labials, its length about $1\frac{3}{8}$ the sagittal length of first of these scales. Two pairs of postmentals, the inner about $\frac{2}{3}$ length of mental and in broad contact with each other on mid-line, the left one also in contact with second lower labial on that side; outer postmentals considerably smaller and each bordered by first postmental, second lower labial and gulars. Gulars small and granular, somewhat irregular in size in mid-line area just behind level of eyes and some of those bordering lower labials distinctly enlarged, a row of four such large scales running back from second postmental on right side but not on left; posteriorly the gulars become somewhat imbricate on throat.

Dorsum covered with small, scarcely raised, rounded, non-imbricate scales that show some variation in size; interstitial areas similar in colour and texture to scales themselves; about 190 scales in a paravertebral line from occiput to a point vertically above the vent. Ventrals on mid-line about $1\frac{1}{2}$ times as long as mid-dorsals, flatter, more elongate, more regular in size and somewhat imbricate; laterally they become more rounded in outline and less overlapping. A total of about 113 scales around mid-body of which about 45 are enlarged belly scales. A patch of feebly enlarged scales in interfemoral region where 6 femoral pores deployed in a shallow inverted V are situated.

Forelimb covered with granular scales similar to those on body but a little larger and, on dorsum of humerus, more distinctly imbricate. Digits of typical *Hemidactylus* type with a strongly expanded adhesive pad which is clearly differentiated from the distal portion of the digit; distal free section of digit very compressed and arising some way proximal to tip of pad; number of enlarged lamellae beneath first to fifth digits respectively 8/8, 9/9, 9/9, 10/10, 10/10 (included in these figures are following numbers of undivided lamellae at base of digits: 3/3, 1/1, 1/1, 0/1, 2/2).

Upper surface of hind limb with granular scales,

becoming larger and more imbricate on the underside of thigh where they are slightly larger than those on belly; scales beneath tibia similar but larger still, about eight in a transverse line equidistant between knee and ankle. Digits generally similar to those of manus, number of enlarged lamellae on first to fifth respectively 7/7, 10/–, 10/10, 11/–, 11/11 (including following numbers of undivided lamellae proximally: 1/2, 1/–, 1/0, –/–, 3/3).

Dorsal scales on tail similar to those on body. Beneath, hemipenial bulge covered by imbricate scales about as large as those on underside of tibia; at sides just posterior to vent, three obliquely arranged enlarged tubercles present. Behind hemipenial bulge a median row of laterally expanded subcaudals, each about twice as wide as long, the first nine or so somewhat irregular; dorsals bordering subcaudal series irregularly enlarged.

Colour in spirit. Very pale buff above although head and extremities of limbs and tail a little darker; no discernible markings on head or body but tail with about seven very weakly indicated darker bands; white beneath but melanophores present on distal half of tail, increasing towards tip. Iris dark, warm buff.

Size. Snout to vent 67 mm; head length 19.8 mm; tail 66 mm.

VARIATION IN PARATYPES. Juveniles have relatively larger heads and shorter tails. First upper labial may enter border of nostril, or not; 10 or 11 upper labials, 7–9 lower labials; inner postmentals may contact second lower labial or not; gular scaling usually more regular than in holotype and large scales running backwards from second postmental usually present on both sides. Subdigital lamellae on first to fifth fingers respectively 7–8, 9, 9–10, 9–10 and 10, on toes 6–7, 9–10, 10–11, 11–12, 11–12. Preanal pores 3–8, most usually 6. Ventral scales on tail base smaller in females than males; expanded row of scales beneath tail may be rather irregular or regular almost to tail base. Largest animal 68 mm from snout to vent, smallest 30.5 mm. Colour in life variable, from pallid pink-grey (at night on pale rocks) to warm grey-buff. Darker markings scarcely discernible when geckoes pale but otherwise some rather vague stippling and transverse bars present on body and tail; one bar on neck, three between pairs of limbs, one on sacrum and 8–12 on tail. Pale animals have greyish supraorbital areas caused by eyes showing through skin. Iris somewhat variable, often a warm buff matching the general colour of the animal when it is not pallid; more orange centrally with a dark veined pattern; pupil with a light rim.

SKELETAL FEATURES (based on radiographs and on skull of BM 1977.990). Skeleton of usual *Hemidactylus* type. Postfrontals crescentic with smoothly convex outer border, supratemporal processes of parietal well differentiated and extending clearly backwards; posterior edge of supraoccipital and adjoining exoccipital forming a ridge running obliquely backwards. 11 teeth in premaxilla, about 31 in maxilla and 35 in dentary. 26 presacral vertebrae, the last without ribs; clavicle looped, interclavicle lozenge-shaped, sternum without fontanelle, three pairs of sternal ribs and one or two attached to xiphisternum; 5 non-autotomic caudal vertebrae.

ECOLOGY. This gecko, which appeared to be strictly nocturnal, was only encountered in Wadi Ayun itself where it was found intermittently over about 5 km of the dry wadi bed that was searched at night. Here it seems to be largely restricted to big (up to 3 m diameter), pale, water-smoothed boulders that occur in extensive patches in the wadi. Occasional specimens were seen in other situations but *H. lemurinus* is almost entirely replaced by other nocturnal climbing geckoes in these (see p. 327 for summary); *Ptyodactylus* also occurred on the large boulders but was much less common. *H. lemurinus* climbs over the surface of the boulders with great agility, leaping across the gaps between and occasionally running upside down beneath them. When pursued it usually flees around the boulder and does not appear to rush to holes or other secure refuges. The presence of babies suggests breeding had occurred in summer although none of the females were gravid in early October. Body temperatures of five normally active animals encountered within three hours of dusk were 25, 25.5, 26, 26.5 and 28°C.

On present evidence the spatial niche occupied by *H. lemurinus* is a particularly narrow one that is also very discontinuously distributed. Furthermore, not all groups of large boulders are occupied and this gecko was absent from such sites at Wadi Sayq and Wadi Raykhut, even though the other nocturnal climbing geckoes found at Ayun (or their close relatives) were present; possibly this was because the boulders were less smooth. The very restricted distribution suggests that *H. lemurinus* may be a relict form. Certainly it

seems unlikely that the ability and morphology necessary for living on open rock surfaces should have been developed specifically to exploit its present very restricted niche. The syndrome of characters involved includes: large head with broad muzzle, large eyes, very smooth scaling, slender limbs, very large adhesive pads and slender tail. The head structure is probably related to snapping up flying nocturnal insects that settle on rocks, such as moths, the smooth scaling allows easy passage through crevices, the long limbs facilitate efficient locomotion and are feasible because the substrate on which they are used is open and they are consequently unlikely to be impeded by vegetation or other projections, the large digital pads allow efficient grip on smooth surfaces. These features are found in a wide range of geckoes occupying a variety of open rock surfaces, including *Ptyodactylus* to which *H. lemurinus* has a superficial resemblance. It seems possible that *H. lemurinus* evolved as a more general rock dweller but that it has been restricted to its present niche by *Ptyodactylus*. This form may well have expanded its distribution quite recently for all the populations across its large range are generally similar. In northern Oman and Musandam an analogous situation may exist for here the rock-dwelling *Phyllodactylus elisae* is probably restricted to relatively high altitudes round Jabal Akhdar and one or two isolated colonies near the sea, the intervening country being occupied by *Ptyodactylus*, suggesting that it has expanded at the expense of *P. elisae*.

Hemidactylus turcicus parkeri Loveridge

Hemidactylus parkeri Loveridge, 1936: 59. Type locality 'Zanzibar'.

DISTRIBUTION. Coastal areas around the Red Sea, Somalia, Hadhramaut, southern Arabian littoral as far as the eastern United Arab Emirates, southern Iran, Pakistan. The natural range of typical *H. turcicus* appears to be the borders of the Mediterranean.

MATERIAL. Umm al Ghawarif camp, 3 km north-east of Salalah: BM 1977.928, 945–55, 2 ♂♂, 2 ♀♀, 8 juv. Thamarit: BM 1978.928, (F. WALKER), 1 juv.

Recently, Lanza (1978) has pointed out that the name *H. parkeri* is available for the populations usually assigned to *H. turcicus* in the area outlined above. He suggests that *H. parkeri* can be distinguished from *H. turcicus* proper by its rather smaller size, usually smaller dorsal tubercles and frequently longer postmentals which are more often in contact with the second lower labial scales. In addition to this, the head and body is usually more depressed and the tail less clearly barred. It is certainly true that the incidence of these features is higher away from the Mediterranean but there is substantial variation, for instance dorsal tubercles are large in parts of Eritrea and the postmental characters vary considerably in their incidence within populations. Nevertheless, there does seem to be a change from typical *H. turcicus* to *parkeri*-type animals around the north of the Red Sea, geckoes from lower Egypt being clearly of the Mediterranean type, while animals from the Gulf of Suez area have some *H. parkeri* characters. Unfortunately the examined samples are insufficient to judge whether two species meet here or if it is merely a zone of relatively abrupt character change within a single species. In view of this uncertainty and the inconstancy of the characters involved, it seems best to regard *parkeri* as a subspecies until the situation can be more thoroughly analysed. While most Arabian animals conform to the *parkeri* type, some from the south-western highlands show differences but too little material is available to assess their status.

H. t. parkeri was seen in Salalah and its environs on verandahs and the outer walls of buildings. It appeared after dusk and was abundant, animals usually being perched a couple of metres from the ground every few paces, especially in the vicinity of lights. These geckoes evidently take some time to colonise new sites: a building put up three years before had none, even though an older neighbouring block was densely populated. *H. t. parkeri* was never encountered far from human habitation.

Hemidactylus yerburii Anderson (*Plates 6–7 and A*)

Hemidactylus yerburii Anderson, 1895: 636. Type localities: 'Haithalhim and Lahej' (but types registered at British Museum as from Haithalhim and Aden).

DISTRIBUTION. Southern Arabia from south-west Saudi Arabia through North Yemen to South Yemen and eastwards to Dhofar; also northern Somalia.

MATERIAL. Khadrafi: BM 1976.1409–13, (MDG), BM 1977.972–74, 4 ♂♂, 10 ♀♀. Wadi Sayq: BM 1977.956–62, 2 ♂♂, 5 ♀♀. Salalah: BM 1975.1378, (T. D. ROGERS), 1 ♂. Wadi Raykhut: BM 1977.963–71, 2 ♂♂, 7 ♀♀. Ayun: BM 1977.976–85, BM 1978.332–33, (MDG), 2

TABLE 2. Geographical variation in *Hemidactylus yerburii* sens. lat.

	Asir	North Yemen	Aden	Hadhramaut	Wadi Sayq, Khadrafi, Salalah	Ayun, Thamarit	Wadi Raykhut	Somalia (Lanza, 1978)
n	17	3	12	4	16	13	10	58
maximum length from snout to vent (mm)	71	66	67	57	74	54	66	62
slender build				yes		yes		
head broad	yes	yes	yes					yes
longitudinal rows of tubercles on body	(14) 16 (18)	14, 16	16 (18)	14	14 (12)	14 (12)	14 (12)	12, 14
relative size of body tubercles (A largest)	C	C	B	B	A	C	B	
number of femoral pores in males	9–14	10–12	12–18	5–6	6–10	5–6	6	4–8
number of basal tail verticils before expanded subcaudals begin: range	2–4	2–6	3–6	1–3	1–4	2.5–7	1–2.5	
mean	2.5		4.5	2.13	2.26	4.46	1.56	
robustness of dorsal tubercles on tail (A most robust)	C	C	C	B	A	B	B	
dark bars on dorsum of tail: range	11–13	11	11–13	few?	10–14	7–9	9–14	
mean	12		12.1		12.2	8	11	
opaque white pigment on dorsal tubercles				yes		yes	yes	

♂♂, 10 ♀♀. 16 km S of Thamarit: BM 1977.975, 1 ♀.

There is a very marked geographical variation among the lizards assigned here to *H. yerburii* and this is especially pronounced within Dhofar (see Table 2). Animals from the forested seaward face of Jabal Qamr (Khadrafi and Wadi Sayq) are large and robust with big, very prominent, dorsal tubercles; the expanded subcaudals extend forwards almost to the tail base; general colouring can change to dark ashy brown and the tail has numerous dark transverse bands. Those from the nearest locality, Ayun, which is 80 km away on the dry landward side of the mountains, are quite different, being much smaller and more slender with smaller, less raised tubercles and the row of expanded subcaudal plates stopping well short of the tail base; the colouring is pale with the tubercles often bearing opaque white pigment, there are yellow transverse bars in life, the tail has fewer, broader transverse bands and is very contrastingly patterned in juveniles. At first sight, the differences between these samples is so marked that it is tempting to regard them as belonging to separate species, especially as the two types appear fairly constant over considerable distances. Thus the animal from Salalah is very similar to those from Wadi Sayq, 90 km away, while one from Thamarit, 47 km from Ayun, is like the members of that population. Also, the two forms approach each other quite closely, Salalah and Ayun being only 35 km apart. They may however be separated here by the crest of the mountains. On the other hand, geckoes from Wadi Raykhut are intermediate, falling between the other samples in size, build, tubercle size and colouring, although they are more like other coastal specimens than the ones from inland. As Wadi Raykhut is also climatically intermediate, lacking the monsoon that

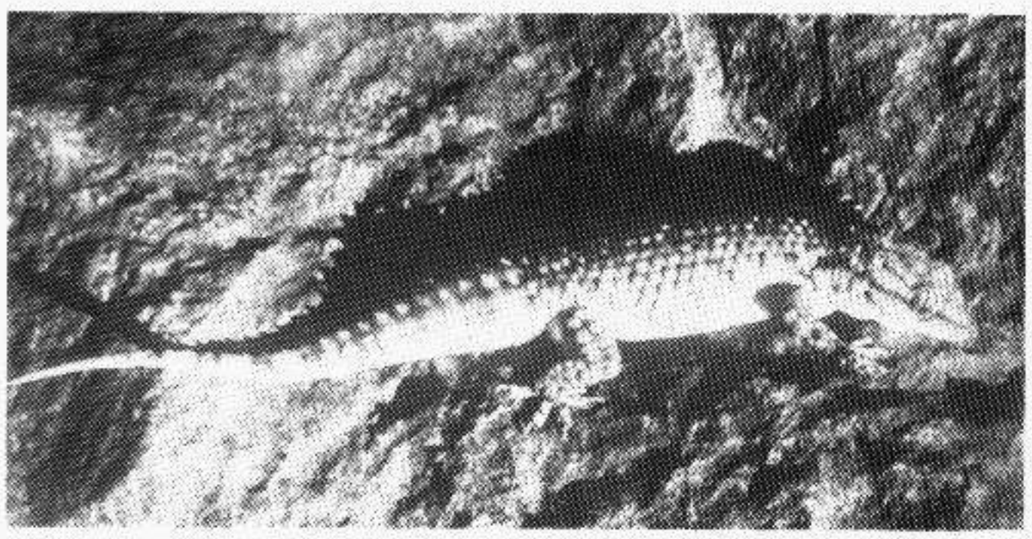

PLATE A. *Hemidactylus yerburii*, ♀, 61 mm from snout to vent, from Wadi Sayq; BM 1977.956.

affects the coastal collecting sites further west, but being much more humid than inland localities, it is possible that the variation found in these geckoes in Dhofar is related at least indirectly to this factor. However, only further collecting will enable the status of these populations to be properly assessed. Lanza (1978) has named Somali material as a separate subspecies, *H. y. pauciporosus*. As there is far more variation within Arabia than between Somali animals and the types of *H. yerburii* it would be consistent to name more forms but, given that most samples of this gecko show clear differences from each other, it is unlikely that such naming would clarify the situation and, as with *H. homoeolepis*, it seems better to wait until the species is more fully investigated.

The geckoes of the *H. yerburii* complex are essentially nocturnal, although occasional animals were seen to be active by day in caves in forested areas. At Wadi Sayq and Khadrafi geckoes were observed climbing on rock faces and boulders in well vegetated places but also occasionally crossing leaf-strewn ground. At Wadi Raykhut these lizards were found in the wadi itself on boulders and rock pavements and sometimes on the gravel wadi bottom; on occasions they were seen close to bushes but these were sparse and more open situations were usually occupied. The dry-country form at Ayun was typically encountered on sloping rock pavement but also on boulders. This population was particularly agile and babies especially would progress in a series of leaps when pursued, with the tail raised to show its conspicuous black and white colouring. Specimens from Ayun collected in June were gravid but none had eggs in early October. At all localities except Khadrafi, *Ptyodactylus* was present and climbed higher than members of the *Hemidactylus yerburii* complex (see p. 327); at Wadi Sayq it appeared also to be confined to drier habitats but this was not apparent elsewhere.

Pristurus carteri (Gray) *(Plates 8–11)*

Spatalura carteri Gray 1863: 236. Type locality: Masirah Island.

DISTRIBUTION. South Arabia from North Yemen to Masirah and the adjoining mainland.

MATERIAL. Milwah Alaud, 220 ft. (70 m): BM 1931.7.16.24–27/1946.8.25.1–4, (BT), 3 ♂♂. Sahalnaut, 350 ft. (110 m): BM 1931.7.16.28–29/1946.8.25.15–16, (BT), 2 ♂♂. Ain al Rizat (= Ain Arzat), 250 ft. (80 m): BM 1931.7.16.12–23/1946.8.25.5–14, (BT), 4 ♂♂, 3 ♀♀, 2 juv. Arzat, 50 m: BM 1976.1434–5, (MDG), 2 ♀♀. Salalah: BM 1971.1387–88, BM 1975.1379–81, 2 ♂♂, 1 ♀, 2 juv. East Khawr, Salalah: BM 1977.1028–29, 1 ♂, 1 ♀. Khawr Sawli: BM 1977.1006–09, BM 1977.1021–23, 2 ♂♂, 3 ♀♀. Crest of Jabal Qara: BM 1977.1024, 1 ♂. 7–10 km E of Ayun: BM 1977.1010–18, BM 1977.1026–27, 2 ♂♂, 5 ♀♀, 4 juv. 49 km from Salalah on Thamarit road: BM 1977.1003–05, 1 ♂, 1 juv. Qarn Shaiba: BM 1930.6.30.7, (BT), 1 ♂. Bin Juay: BM 1930.6.30.5–6, (BT), 1 ♂, 1 ♀. Al Hallaniya, Kuria Muria Islands (17° 31′N 55° 58′E): BM 1976.1429–33, (R. DALY/MDG), 4 ♀♀. Jazir (18° 30′N 56° 30′E): BM 1969.306–11, (G. POPOV), 3 ♂♂, 3 juv.

Samples differ considerably in colour, tending to match the substrates on which they were collected. This variation is not due merely to physiological colour change, for animals from different localities kept in captivity for over a year still showed marked differences. Parker (1931) described animals from Salalah plain as a separate subspecies, *P. c. tuberculatus*, because the material available to him has enlarged tubercles on the flanks but such tubercles occur sporadically elsewhere (for instance Thamarit and North Jol, Hadhramaut) and, until a comprehensive analysis of variation in *P. carteri* is carried out, it is impossible to assess the validity of Parker's form. In contrast, the populations found in coastal south-western Arabia which are often referred to *P. carteri collaris* (Steindachner, 1869) are very distinctive. They appear to meet more typical *P. carteri* at Wadi Hajr in South Yemen without intergrading (material in British Museum) and should probably be regarded as a separate species.

There is considerable sexual dimorphism in Dhofar *P. carteri*, males having a laterally compressed, strongly fringed tail, brighter reddish spots on the flanks than the females and a large canary-yellow patch on each side of the belly. It was evident in late September and October, 1977, that breeding had recently occurred at several sites, for some near-hatchlings were about.

Pristurus carteri and its close relatives (including *P. minimus*) form one of the structurally most aberrant groups of geckoes and opportunity was consequently taken to examine some aspects of its ecology to see if this too is exceptional. From observations made on over 120 animals at eight sites, it appears that *P. carteri* in S Dhofar usually occupies open, dry, flattish areas,

although occasionally it is found on slopes as well, if the gradient is not very abrupt. The substrate is nearly always hard, and may be compact sand with or without stones, crusted silt, hard ground with scattered flints, or coarse gravel. Vegetation is usually low, most shrubs being under 0.5 m in height, and density varies, plants sometimes being extremely sparse. In such situations, *P. carteri* is abundant and the commonest lizard of its size.

The range of activity times is very broad. At all sites animals were active in the morning and there was a tendency to become less conspicuous in the afternoon but after dusk the level of sightings rose abruptly and continued for some hours after sunset. It seems probable that activity patterns are flexible in this species and that the relative degrees of diurnality and nocturnality vary with season and temperature.

During the day, *P. carteri* is often seen sitting out in the open a long way from the nearest vegetation, distances of 5 m or more being common. Lizards will remain more or less immobile for very long periods and, on two occasions, individuals were noted very close to the same spot for over three hours. Animals often face into the wind and it appears that they are hunting passively, sitting and waiting for prey to pass or be blown by. Occasionally an individual was seen to run forwards to snap up an insect, and stomach contents suggest that *P. carteri* eats a fairly wide range of mainly arthropod prey. This mode of foraging is particularly appropriate for habitats with relatively low productivity where exploitable prey is sparse and irregularly distributed in time and space, so that active hunting might involve the risk of expending more energy than would be recouped by captures. This may well be true of the situations in which *P. carteri* is found which are also suitable in being very open so that a large area can be scanned from one position.

Sitting in the open for long periods during the day must produce problems of thermoregulation, even in autumn. Body temperatures of eight lizards naturally active in the late morning were 38, 38, 38, 38.5, 39, 39.5, 39.5 and 40.5°C, substantially higher than those usually reported for geckoes (see for example Werner & Goldblatt, 1978). A captive animal subjected to a temperature of 43.5°C for some minutes panted but did not collapse, so it must still have been below its upper critical temperature. As well as being able to tolerate high body temperatures, *P. carteri* employs a number of strategies to reduce heat load. Radiation input is sometimes restricted by facing the sun and exposing as small a surface to it as possible. Like many other lizards with physiological colour change, *P. carteri* is dark when it first emerges in the early morning becoming lighter as the temperature rises and thereby probably increasing the proportion of energy in the visible part of the solar spectrum that is reflected. With increasing temperature, the lizard keeps its body as far from the hot ground as possible. This may be by posture: although animals often crouch during cool periods (Pl. 9) they rise high on their legs in hot conditions, restricting substrate contact to finger and toe tips and one point on the tail (Pl 10). Alternatively the lizard may climb on to an object: on Masirah this is often a low shrub (P. B. Mordan, pers. comm.) but in Dhofar stones and even pats of camel dung seem to be more usual; the lizard may also position itself to take full advantage of any shade the object provides (Pl. 11). The effectiveness of reducing contact with the ground can be judged from the following observations at Ayun: at noon (12.10.77) ground temperature was 50°C, the top of a stone 5 cm high was 42°C, of one 10 cm high 40°C and the air 3 cm above this 36.5°C. At night, foraging behaviour seemed similar, but the lizards moved about more. Body temperatures of ten naturally active animals were 22, 23, 23.5, 24.5, 26, 26, 26.5, 27, 28 and 29°C.

Although no direct observations are available, it is very probable that *P. carteri*, like other small lizards that are active by day in open places, is subjected to heavy predation by visual hunters, especially birds. The extremely good match of dorsal colour to average background suggests that there is strong selective pressure for crypsis, and camouflage is certainly very effective, lizards being very difficult to detect until they move and, if still, hard to find again should the observer take his eyes off them for a moment. Avoidance of detection is consequently enhanced by the long periods of inactivity already noted for *P. carteri*, and by movement being restricted to short vigorous bursts. Lizards taking up a new foraging site abandon their original one abruptly and proceed in a series of rapid spurts stopping suddenly at the end of each one so that human eyes, at least, tend to lose track of them. If pursued, *P. carteri* may make very long dashes to cover, runs of 10 m or even 20 m not being unusual. Refuge may be taken under stones but lizards often flee to plants, where complex shadows improve their camouflage, and may crouch there

hiding their own shadow. If captured, these geckoes do not bite but the tail may be shed if handled and the large pupil is contracted; possibly this makes the vulnerable eyes and head less liable to attack as the conspicuous black pupil virtually disappears and the iris is roughly the same colour as the surrounding skin.

Males often raise and shake the tail, a gesture made more conspicuous by its being deep, laterally flattened, fringed and often rust-coloured at the tip. This may occur when a lizard is approached by the observer but is more usual when another *Pristurus* comes near or waves its own tail. It is almost certainly a social signal and does not seem to be a way of directing predators to the expendable tail, for it is not usually performed by a fleeing lizard or by females. However, the fact that it was also elicited by other moving objects suggests that there may be a secondary function. Perhaps tail waving informs potential predators that they have been seen and that any pursuit will be of a gecko aware of its predicament and consequently costly, in terms of effort, to catch.

P. carteri is the only Arabian lizard known to hunt regularly by day and night. Nocturnally it occupies situations similar to some exploited by *Bunopus spatalurus* in northern Oman and may well be responsible for the more restricted occurrence of this species in southern Arabia (see p. 277). But by day it fills a niche very similar to that of members of the agamid genus *Phrynocephalus*, although this is found on a wider range of substrates including very soft acolian sand, the preferred habitat of the one Arabian endemic species *P. arabicus*. However, in many other respects the ecology of this species is very like that of *Pristurus carteri*. In the eastern United Arab Emirates, it is about the same size, occupies flattish open situations away from vegetation and hunts by sitting and waiting for invertebrate prey. High body temperatures are tolerated and heat input reduced by becoming paler and by adopting a high stance; predation is avoided by good camouflage, immobility, the restriction of movement to rapid dashes and often sheltering crouched in the shade of plants when pursued. As with *Pristurus carteri*, *Phrynocephalus arabicus* does not bite when captured and appears to communicate by conspicuous tail movements. There are differences between the two, for instance, the *Phrynocephalus* functions at markedly higher temperatures, but considering that they belong to different families, one primarily nocturnal and the other diurnal, the convergence is very close.

In summary, *Pristurus carteri* is a gecko occupying a niche similar to that of some small ground-dwelling agamids, and iguanids, and it may well be that some aspects of its peculiar morphology and that of its close relatives is related to living in situations not invaded by other geckoes.

Pristurus minimus Arnold (*Plate 12*)

Pristurus minimus Arnold, 1977: 93. Type locality: Jazir coast, 18° 30′N 56°30′E, Sultanate of Oman.

DISTRIBUTION. South-east Arabia.

MATERIAL. 13–16 km S of Thamarit: BM 1977.1030–32, 1 ♂, 2 juv. Thamarit: BM 1978. 931, (F. J. WALKER), 1 ♂.

This material does not differ obviously from the types. It shows that, like two other apparent south-east Arabian endemics, *Uromastyx thomasi* and *Acanthodactylus masirae*, *P. minimus* has a range extending at least from Masirah Island to Dhofar. The species was encountered in a flat, rather hard sandy area with softer hummocks supporting low (0.5 m high), dense woody shrubs. Nearly all individuals seen were within about 1.5 m of these plants and fled deep into them if disturbed. This sort of situation is typical of *P. minimus* on Masirah (T. D. Rogers) but examples taken at Al Ajaiz, 19°32′N 57°12′E, were among sparse, low grass (M. D. Gallagher). The relatively slender build and narrow head of *P. minimus* is not typical of the *P. carteri* group to which this species belongs (Arnold, 1977) and may be connected with its habit of taking refuge in dense vegetation, something that *P. carteri* at least does not typically do. Most animals obtained near Thamarit in October were immature but a few adults were present. Most were seen in the late afternoon but some were active after dark.

Pristurus rupestris Blanford

Pristurus rupestris Blanford, 1874a. Type locality: Muscat.

DISTRIBUTION. North-east Africa, Jordan, Arabia and coastal Iran.

MATERIAL. Wadi Sayq: BM 1977. 1048–54, 5♂♂, 2 ♀♀. Khadrafi: BM 1977.1038–42, 3 ♂♂, 1 ♀, 1 juv. Rakhyut: BM 1976.1445, (MDG), 1 ♀. Raysut: BM 1977.1046, 1 ♀. Salalah: BM 1975.1382, (S. MOULT), BM 1976.1444, (MDG), BM 1977.1034–37, 2 ♂♂, 2 ♀♀. In: BM 1931–7. 16.11, 1 ♂. Ain Arzat: BM 1931.7.16.8–10, 1 ♂, 2 ♀♀.

Fuzul, Jabal Qara: BM 1931.7.16.7, 1 ♂. Khawr Sawli: BM 1977.1047, 1 ♂. Khawr Rawri (17°02′N 54°26′E): BM 1977.1033, 1 juv. Ayun: BM 1977.1058–64; 5 ♂♂, 1 ♀. 40–44 km from Salalah on Thamarit road: BM 1977.1055–57, 2 ♂♂, 1 ♀. Tawi Atair: BM 1977.45–46, (MDG), 2 ♂♂. Wadi Raykhut: BM 1977.1043–45, 1 ♂, 2 ♀♀. Hasikiya, Kuria Muria Islands: BM 1974.4052.

Over its large range this diminutive gecko exhibits marked variation, especially in colouring, and even neighbouring populations may show some differences. In Dhofar, animals from moist habitats, such as Wadi Sayq, Khadrafi and Jabal Qara, are relatively large (growing to about 29 mm from snout to vent), dark and often with one or two prominent blackish spots in front of the shoulder as well as very heavy markings on the throat. In contrast, drier habitats tend to be occupied by smaller, paler animals on which dark markings are reduced, although even here animals from dark backgrounds tend to be sombre. As with *P. carteri*, physiological colour change is not the main cause of this variation.

In Dhofar animals, the underside of the tail is opaque white; this is extensive enough to be visible in side view and is conspicuous when a lizard raises its tail and waves it, especially in dark populations. An obvious light underside to the tail also occurs in some south-west Arabian *P. rupestris* but is absent in those from northern Oman.

P. rupestris is by far the most widespread lizard in southern Dhofar, occurring at all localities visited from sea level to over 1,000 m above it. It was encountered in towns and villages, on rubbish dumps and beaches, in moist woods, grassland and in the arid country north of the mountains. In all these situations *P. rupestris* was usually seen on rocks, stones or man-made equivalents such as concrete (83% of 184 observations) but it also occasionally occurred on earth and more or less compact sand, although usually in the vicinity of hard objects. It has been recorded more rarely on the trunks and branches of trees, on corrugated iron buildings, on car-wrecks and on packing cases. 78% of 174 lizards checked were perched or climbing on objects but only 22% of the 174 were more than a metre from the ground and only 8% above 1.25 m. The great majority of animals was active by day but at most sites a few individuals could be found out at night. Like *P. carteri*, *P. rupestris* adopts a 'sit and wait' hunting strategy often stopping in one place for long periods. Because of its very small size no direct temperatures could be taken, but in such a minute lizard temperature is likely to be very similar to that of the place where it is sitting. Daytime perch temperatures (°C) of 24 previously undisturbed animals were 25° (3), 28 (2), 28.5 (1), 29 (2), 31 (2), 32 (3), 32.5 (1), 33 (2), 34 (2), 34.5 (1), 35 (5). The lower ones were taken in the early morning, when lizards are usually in the sun, and the higher ones later when many individuals have moved to the shade; warm animals tend to be paler. Two perch temperatures taken after dusk were 27°C.

P. rupestris rarely perches far from a refuge such as a crevice or interstices between stones. Of 124 individuals recorded, 54% reached a retreat within 0.5 m and 83% within a metre. Such figures apply to lizards that are hotly pursued; if mildly disturbed they may retreat less precipitately but over larger distances.

Tails, at least of males, are often raised and curled forwards and waved or shaken, either apparently spontaneously or in response to a moving object, particularly another *P. rupestris*. In one case a male curled his tail forwards and a nearby female immediately wagged hers from side to side. Another male was seen following a female and wagging his tail laterally. The meanings of this repertoire of apparent signals remain to be investigated.

P. rupestris is intermediate in morphology between primitive members of the genus like *P. celerrimus* Arnold (1977) and advanced forms like *P. carteri* and it is also intermediate in its behaviour. Like *P. celerrimus* it is scansorial but it resembles *P. carteri* in its more static foraging methods and more complex tail signalling. However, it is less plastic than the latter species in its times of activity and probably usually operates at lower maximum temperatures.

Ptyodactylus hasselquistii (Donndorff) (*Plate B*)

Lacerta hasselquistii Donndorff 1798: 133. Type locality: Cairo.

DISTRIBUTION. North Africa, Arabia and north to Syria, Iraq and south-west Iran.

MATERIAL. Wadi Sayq: BM 1977.1077–80, 2 ♂♂, 2 ♀♀. Ayun: BM 1977.1065–71, BM 1978.1314, 3 ♂♂, 1 ♀, 4 juv. Wadi Raykhut: BM 1977.1072–76, 3 ♂♂, 2 juv. Also seen 16 km S of Thamarit.

The *Ptyodactylus hasselquistii* complex shows significant

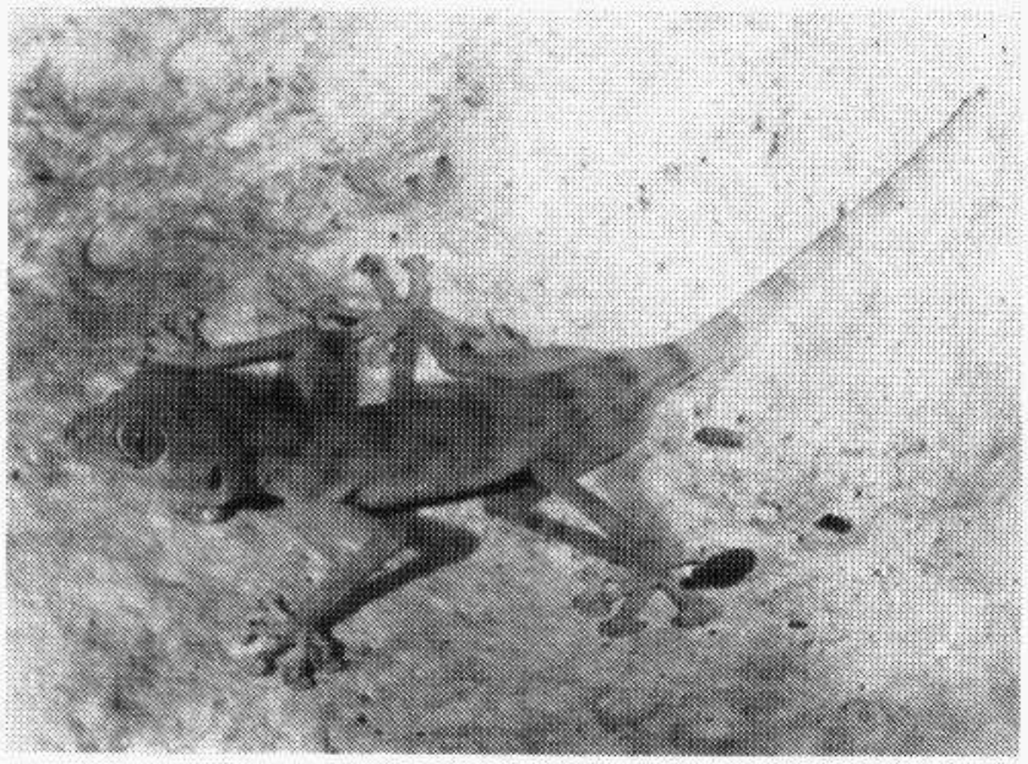

PLATE B. *Ptyodactylus hasselquistii*, immature animal, about 55 mm from snout to vent, from Ayun.

variation over its very large range and in Palestine at least there are clear cut allopatric units with many of the characteristics of full species (Werner, 1965; Frankenberg, 1974). Considerable local and individual variation is apparent in Arabia especially in body size, head shape, pattern and some scale features but, at present, no clear subdivisions are apparent. In Dhofar, the animals from Wadi Sayq were particularly large, the biggest individual being a male 98 mm from snout to vent.

In Dhofar, *Ptyodactylus* was typically encountered on open rocky surfaces such as cliffs, large boulders and the walls and ceilings of shallow caves, although occasionally also seen on screes and on the ground, especially when travelling between isolated rocks. At all sites, it tended to occur further from the ground than the *Hemidactylus* species in the same general habitats. At Wadi Sayq it was also commoner in drier situations than *H. yerburii*. As in northern Oman, *Ptyodactylus* was very active after dusk but was also often seen sitting out on open surfaces during the day. Body temperatures of six animals naturally active after dusk were 27, 27.5, 28, 28, 29 and 30°C.

Stenodactylus doriae (Blanford)

Ceramodactylus doriae Blanford, 1874a: 454. Type locality: Bandar Abbas, Iran.
Ceramodactylus major Parker, 1930: 594. Type locality: Rub' al Khali.

DISTRIBUTION. Most of Arabia, neighbouring Palestine, Jordan, Iraq and south-west Iran.

MATERIAL. 'Rub' al Khali': somewhere on B. Thomas' 1930 journey to Mugshin (see map in Thomas, 1932), BM 1930.6.30.1/1946.8.23.57, 1 ♀; type of *C. major*. Kharaiyim Fasad (18°33'N 53°00'E) 850 ft. (260 m): BM 1931.7.16.5, (BT), 1 ♀. Near Shisr (18°16'N 53°30' E): BM 1978.336–37, (MDG), 1 ♂, 1 ♀.

Ceramodactylus major Parker appears to be based on a large specimen of *S. doriae*. Some of its apparently distinctive features, such as large digital fringes are partly a result of allometric growth and since its description many intermediate animals have been collected. *S. doriae* is widespread in soft-sand habitats.

Stenodactylus leptocosymbotes Leviton & Anderson

Stenodactylus leptocosymbotes Leviton & Anderson, 1967: 167. Type locality: halfway between Dubai and Abu Dhabi, 24°50'N 54°45'E (= Ras Ghanada), United Arab Emirates.

DISTRIBUTION. South-east and southern Arabia: eastern United Arab Emirates and Oman, extending westwards from Dhofar into South Yemen where it appears to intergrade with *S. slevini*.

MATERIAL. 7 km E of Wadi Ayun: BM 1977.1096, 1 ♀. 16 km S of Thamarit: BM 1977.1087–95, 5 ♂♂, 7 ♀♀, 3 imm. E of Thamarit (17°55'N 54°55'E) 350 m: BM 1976.1450, (MDG), 1 ♂. 60 km NE of Dauqa: BM 1978.333, (MDG), 1 ♂.

The systematic position of *S. leptocosymbotes* is discussed elsewhere (Arnold, 1980). In most areas it occurs on harder substrates than *S. doriae* and this seems to be the main factor in their ecological separation. At night *S. leptocosymbotes* was active at the same time and often in the same places as *Pristurus carteri* near Thamarit but there was a tendency for the latter to occupy rather harder ground.

Tropiocolotes scorteccii Cherchi & Spano'

Tropiocolotes scorteccii Cherchi & Spano', 1963: 29. Type locality: El Safà, South Yemen.

DISTRIBUTION. South Arabia: Hadhramaut, Dhofar.

MATERIAL. Ayun: BM 1977.1099, 1 ♂. 16 km S of Thamarit: BM 1977.1097–98, BM 1978.932, BM 1978. 1096–97, 4 ♂♂, 1 juv. Thamarit: BM 1980.210, (J. N. BARNES), 1 ♂. Wadi Ghayz: BM 1980.209, (J. N.

TABLE 3. Variation in southern Arabian *Tropiocolotes*

	Hadhramaut (types of *T. scorteccii*)	Ayun	Thamarit	Wadi Ghayz	Wadi Raykhut	Bir ba Shu'aythan
n	3	1	6	1	1	1
scales along mid-line from axilla to groin	—	28	25–29	31	35	34
scales round mid-body	50–62	42	36–42	46	41	47
keeling on dorsal scales	strong	strong	very strong	strong	weak	weak
keeling on ventral scales	yes	yes	yes	yes	no	no
postmentals in contact	no	yes	yes	yes	yes	yes
gulars bordering first and second lower labials	large	small	small/ moderate	moderate	large	large
femoral pores: ♂	?	yes	yes	?	?	?
♀	?	?	?	no	no	no
lamellae under fourth hind toe	15–17	14	14–16	16	17	20
tail-tip dark in adults	?	yes	yes	no	no	?
apparent adult size (snout to vent, mm)	21.5	24	25	24	25.5	30

BARNES), 1 ♀. Wadi Raykhut: BM 1978.1098, 1 ♀. Bir ba Shu'aythan: BM 1976.1451, (MDG), 1 ♀.

The more obvious variation in the thirteen known specimens of southern Arabian *Tropiocolotes* is shown in Table 3. From this it may be seen that, not only are there substantial differences between animals from Hadhramaut (types of *T. scorteccii*) and Dhofar, but also between western and eastern samples within the latter area. It is not even certain that only a single species is represented although, until more material becomes available, it is most convenient to refer all the material listed above to *T. scorteccii*. In their coarse, imbricate, homogeneous scaling, their carinate subdigital lamellae and presence of enlarged postmentals, these lizards are most similar to *T. tripolitanus* of north Africa and, to a lesser extent, to *T. steudneri* which is sympatric with it. At least the more western Dhofar animals differ from *T. tripolitanus* in possessing femoral pores in the males but the character usually employed to distinguish *T. scorteccii* from this form, the separation of the postmentals on the mid-line, (see for instance Leviton & Anderson, 1972), does not hold here. The two more eastern Dhofar specimens approach *T. steudneri* in the weak keeling of their body scales but there are fewer dorsals along the body (34 and 35 from axilla to groin levels compared with usually 40 or more) and they lack a large second pair of postmentals.

Animals from Ayun, Thamarit and Wadi Ghayz are like the types of *T. scorteccii* in having a dark stripe on each side of the head and neck that is joined to its partner by a conspicuous transverse neck band and in possessing another dark band on the tail base; these features are not conspicuous in more eastern animals. There are three or four dark bands on the body in the Ayun and Wadi Ghayz specimens but those from elsewhere have irregular dark and light markings, the latter sometimes forming transverse rows of spots. Bars on the tail are prominent in the Ayun, Wadi Ghayz and Wadi Raykhut individuals but are not very clearly defined elsewhere; the distal part of the tail is very dark at Ayun and Thamarit. All animals were suffused with yellow when alive. Within Dhofar, only males are known from some sites and only females from the others, so it is possible that some apparent geographical variation is in fact sexual.

The Ayun lizard was collected by day under a small stone on a sandy plain with scattered gravel. Those from near Thamarit came from coarse gravelly slopes over which they were found walking extremely slowly at night; when disturbed they raised and waved their conspicuous black-tipped tails. The female from Wadi Raykhut was also on gravel and also moved very

slowly but she never waved her tail. This behavioural difference between Thamarit and Wadi Raykhut animals was still apparent after two months in captivity.

Family AGAMIDAE: agamid lizards

Agama adramitana Anderson

Agama adramitana Anderson, 1896: 31. Type locality: 'Hadramaut'.

DISTRIBUTION. West and south Arabia, from Taif in the north to Dhofar in the east.

MATERIAL. Wadi Sarfait: BM 1977.1101–06, 2 ♀♀, 4 juv. Zeerat water hole, Wadi Sayq: BM 1977.1100, 1 ♀.

Agama adramitana is a member of the *Agama cyanogaster* complex which occurs in north-eastern Africa as well as Arabia. In the latter area it is represented by three taxa which Klausewitz (1954) regarded as subspecies, namely *A. cyanogaster cyanogaster* (Rüppell, 1835), *A. c. annectans* Blanford, 1870 and *A. c. phillipsi* Boulenger, 1895. In Arabia there is *A. adramitana* itself which Klausewitz also made a subspecies of *A. cyanogaster* and *A. c. yemenensis* Klausewitz, 1954 described from Sana'a, North Yemen. Examination of over eighty specimens in the British Museum (Natural History) makes it clear that the two Arabian taxa act as distinct species. In consequence they cannot both be regarded as subspecies of *A. cyanogaster*. Which, if either, is conspecific with it cannot be decided without a comprehensive revision of the *A. cyanogaster* complex and, until this is carried out, it seems best to refer to them simply as *A. adramitana* and *A. yemenensis*. They merit species status because they occur in very close proximity in at least three widely separated regions without intergrading: near Sana'a (both forms occur at Al Nabi Shuaib, 30 km west of Sana'a), around Abha in Asir, Saudi Arabia and near Taif further to the north.

Although some juveniles are hard to identify, adults are nearly always easily distinguished by the following criteria.

1. *Tail length*. In *A. adramitana*, the intact tail is 1.7–2.15 times the length of the head and body (n = 22) whereas in *A. yemenensis* it is only 1–1.6 times as long (n = 19). The only exceptions encountered were two *A. yemenensis* from Taif in which the figure was 1.66 and 1.84.
2. *Head shape*. In areas where the two species both occur, the head of *A. yemenensis* is more depressed and relatively broader, this difference being most marked in adult males.
3. *Shape of tail base*. The tail base is somewhat depressed in adult *A. adramitana* but its width is less than 1⅓ of its depth in most cases. In adult *A. yemenensis* depression is more marked and width often exceeds 1⅓ times the depth, especially in males.
4. *Dorsal scales on body*. In adult *A. adramitana*, the large mid-dorsal scales are well differentiated from the smaller laterals and are usually clearly keeled. Keeling is occasionally weak but is discernible on the hind back and over the sacral region. In *A. yemenensis*, the mid-dorsals are smooth in nearly all adults and at most slight keeling is present. Some keeling is however usual in half-grown and young *A. yemenensis*, being strongest in the latter, but it is customarily weaker than in equivalent-sized *A. adramitana*. Some geographical variation exists in this feature and, among young *A. yemenensis*, keeling is least developed in specimens from the Sana'a region.
5. *Callose scales*. There is variation in the number of enlarged scales that form a transverse row immediately anterior to the vent. These are very big and callose in mature males but are also discernible in females. In *A. adramitana* (n = 38) the number varies from 4 to 8 (4–7 in 81.6%) while in *A. yemenensis* (n = 38) the range is 7 to 12 (9–12 in 73.7%, 8–12 in 97.4%).
6. *Dorsal scales on tail base*. In *A. adramitana*, these are often fairly flat and clearly mucronate and the lateral profile of the tail base is relatively smooth. In *A. yemenensis*, on the other hand the scales are frequently raised and rather blunt and the lateral profile of the tail base may be distinctly serrated.
7. *Dorsal body pattern of preserved animals*. Mature males of *A. adramitana* are often dark with light speckling and sometimes a broad, light vertebral stripe, especially anteriorly; females may have a line of two or more rust-coloured spots on each side behind the shoulder; in barred individuals the dark, transverse bands are well defined and contain clear, light areas. In *A. yemenensis*, mature males may be dark or speckled but appear to lack a vertebral stripe; females do not seem to have rusty spots behind the shoulder; barred animals have the transverse bands less well defined and often broken up and the pattern may consist of rows of dark-edged, light ocelli.
8. *Tail colour in preserved males*. The tail-base in *A. adramitana* is often much paler than the body and

flushed red or orange whereas in *A. yemenensis* any contrast is much less marked.

9. *Maximum size*. *A. adramitana*: males up to 150 mm from snout to vent, females up to 137 mm. *A. yemenensis*: males up to 130 mm, females up to 115 mm.

A. adramitana is found up to about 2,000 m above sea level while *A. yemenensis* occurs from about this height to around 3,000 m. Its range is also more restricted, consisting of a number of disjunct sections in south-western Saudi Arabia and North Yemen. Both species appear to be essentially rock dwelling.

The Dhofar *A. adramitana* are the most easterly recorded and are generally similar to the type series from the Hadhramaut region. Only females were collected; these had bluish heads in life, often with lighter spots, and a blue reticulation on the throat; two or three rusty spots were present on each dorsolateral fold, the most anterior being at about the level of the shoulder, but were less clear in juveniles.

All specimens seen were on large boulders in the vicinity of water in precipitous wadis surrounded by dense vegetation. They were usually encountered on the tops of the boulders, sometimes 4 m from the ground. Most individuals were shy but apparently curious, slipping out of sight between the boulders when approached to reappear and watch their hunter from another position. An adult male observed at Sarfait had an intense blue head, throat and back and bobbed its foreparts very deliberately three times, bringing its body down to the rock, pausing, stretching high on its forelegs and pausing again before repeating the sequence. Body temperatures of naturally active animals were 36, 37, 37, 37, 37.5 and 37.5°C.

Agama flavimaculata (Rüppell)

Trapelus flavimaculatus Rüppell, 1835: 12. Type locality: 'Djetta' (= Jeddah, Saudi Arabia).

Agama jayakari Anderson, 1896: 65. Type locality: Muscat.

DISTRIBUTION. Much of Arabia, except the north-east; also Sinai and Egypt.

MATERIAL. Thamarit: BM 1978.933, (F. J. WALKER), 1 ♂; BM 1980.212, (J. N. BARNES), 1 ♀. Bin Ju'ai: BM 1930.6.30.9, (BT), 1 ♀. Bil Lukish (18°55′N 53°17′E) 1,000 ft. (310 m): BM 1930.6.30.8, (BT), 1 juv. Bin Khautar: BM 1930.6.30.10, (BT), 1 juv. Bir ba Shu'aythan: BM 1976.1453, (MDG), 1 juv.

A. flavimaculatus and *A. jayakari* were described from opposite sides of Arabia at a time when the interior of the peninsula was herpetologically unknown but material now available from Yemen, Hadhramaut, Dhofar and northern Oman makes it clear that these forms are conspecific.

In the United Arab Emirates, this agama occurs on stable sand and gravelly surfaces, usually with bushes and shrubs on which it is often found sunning itself; in disturbed areas, heaps of stones and earth may also be used for this purpose.

Agama sinaita Heyden (*Plates 13–14*)

Agama sinaita Heyden, 1827: 10. Type locality: 'Sinai'.

Agama neumanni Tornier, 1905: 384. Type locality: Arabia (type specimens come from Lahej, South Yemen).

DISTRIBUTION. Egypt, Sudan, south-east Libya, Palestine, Jordan and Arabia where it occurs in the north, on the western and southern peripheries and in northern Oman.

MATERIAL. Raysut: BM 1977.1108–1111, 1 ♂, 1 ♀, 2 juv. Salalah: BM 1975.1383, (T. ROGERS, S. MOULT), BM 1977.63, (MDG), BM 1977.1107, BM 1977.1112–17, 2 ♂♂, 1 ♀, 6 juv. Jurbayb: BM 1931.7.16.37, (BT), 1 ♂. Ain Arzat: BM 1931.7.16.38–40, (BT), BM 1976.1454, (MDG), 4 juv. Milwah Alaud: BM 1931.7.16.41, 1 juv. Ayun: BM 1977.1120–27, 1 ♂, 2 ♀♀, 5 juv. Sudh (17° 02′N 55°04′E): BM 1976.1455–57, (MDG), 3 juv. Hasik: BM 1977.1119, 1 juv. Wadi Raykhut: BM 1977.1118, 1 juv.

Tornier regarded his *A. neumanni* as being related to *A. sinaita* but described it as differing in having large, mucronate scales on the dorsal surfaces of the posterior head, the limbs and the body, those on the latter being as big as the proximal dorsal caudals. Also the direction of imbrication of the large head scales is forwards rather than lateral, there are four preanal pores instead of six, the nostril is said to be directed upwards and forwards, not sideways and weakly backwards, and the fourth toe is nearly as long as the third. In fact, the two forms appear to be conspecific for, although animals from south-west Arabia, whence *A. neumanni* was described, are superficially very different from *A. sinaita* to the north and east, they are connected by intermediates. Scales on the dorsal surfaces of the head,

body and limbs are small in Libya, Egypt, Sudan, Palestine, Jordan and north-west Saudi Arabia but they begin to increase in size south of Jeddah reaching their maximum dimensions in the Aden area; eastwards from here, size decreases again and in Hadhramaut and beyond is not larger than in north-west Arabia. The direction of imbrication of the scales on the posterior head also varies geographically but rather more irregularly: it is roughly forwards in some animals from Palestine and in most from west and south-west Arabia and northern Oman but, in other individuals examined, imbrication is directly or obliquely lateral. Although four instead of six preanal pores is usual in south-west Arabia, it exists as a minority condition elsewhere. Nostril direction and relative toe lengths vary irregularly.

Dhofar *A. sinaita* are similar to neighbouring populations in Hadhramaut but seem to grow rather larger than those from Masirah Island and northern Oman (up to at least 96 mm from snout to vent compared with an apparent maximum of 85 mm). This agama is a diurnal, 'sit and wait' forager that occupies a range of open habitats. At Ayun, adults were seen only in rocky wadis on low rocks and on pavement areas; a few young also occurred here but most were encountered outside wadis on open gravelly slopes and flatter surfaces. A similar habitat difference was apparent at East Khawr, Salalah where adults were on a rock outcrop and young were abundant on rather hard open sand with plants. At Wadi Raykhut animals occurred both on low rocks and on the gravel of the wadi floor, sometimes fleeing into dense vegetation. *A. sinaita* was occasionally seen in less typical habitats such as on earth mounds in open grassland (Salalah plain), on a beach and among rubbish on the wet muddy shore of a *khawr* (sea inlet). This species occupies drier habitats than *A. adramitana* and does not climb so high, spending substantial time on the ground. Body temperatures of normally active animals were 36, 37, 37.3, 38 and 38.5°C.

Phrynocephalus arabicus Anderson

Phrynocephalus arabicus Anderson, 1894: 377. Type locality: 'Hadramaut'.

DISTRIBUTION. Most of Arabia, except the west.

MATERIAL. Haylat Ash Shisur: BM 1930.6.30.11 (BT), 1 ♀. Suwahib (20°00′N 51°30′E) 600 ft. (185 m): BM 1931.7.16.32–33 (BT), 2 ♂♂.

This species is typical of soft, wind-blown sand habitats.

Phrynocephalus maculatus Anderson

Phrynocephalus maculatus Anderson, 1872: 389. Type locality: Awada, Shiraz, Iran.

DISTRIBUTION. Arabia, southern Iraq, Iran, Afghanistan, Pakistan.

MATERIAL. Jiddat al Hamsha (18°40′N 52°40′E) 900 ft. (275 m): BM 1931.7.16.35, (BT), 1 ♀. Bil Rizaz (18°17′N 53°37′E): BM 1930.6.30.12, (BT), 1 ♂. Ramlat Shu'ait: BM 1931.7.16.36, (BT), 1 ♀. Bir ba Shu'aythan: BM 1976. 1460–61, (MDG), 2 juv.

P. maculatus occupies harder substrates than *P. arabicus*. In the eastern United Arab Emirates it is often seen on dry *sabkha* (salt flat).

Uromastyx microlepis Blanford

Uromastix microlepis Blanford, 1874b: 658. Type locality: Basrah.

DISTRIBUTION. Arabia, southern Iraq, south-west Iran.

MATERIAL. Bin Khautar: BM 1930.6.30.3, (BT), 1 ♂. Wadi Qitbit (19°09′N 54°30′E): (MDG), adult and fragments.

U. microlepis is very probably conspecific with *U. aegyptius* (Forskål, 1775) of Egypt and Sinai, differing mainly in lacking enlarged tubercles on the flanks. It is the most widespread *Uromastyx* in Arabia occurring in dry, often hard substrates, either sandy or gravelly, over much of the peninsula except the western and southern peripheries where it is replaced by a series of other species. The Wadi Qitbit specimens were taken from beneath the nest of a buzzard (*Buteo* sp.) and appear to have been items of prey.

Uromastyx thomasi Parker (*Plates 15–16*)

Uromastyx thomasi Parker, 1930: 595. Type locality: Bu (= Bin) Juay, Dhofar.

DISTRIBUTION. Apparently confined to the coastal hinterland of south-east Arabia.

MATERIAL. Bin Juay: BM 1930.6.30.2/1946.8.14.43, (BT), ♂, holotype of *U. thomasi*. Thamarit: BM 1980.213, (J. N. BARNES), 1 ♀. Wadi Hauf (= Wadi Haluf): BM 1931.7.16.46, (BT), 1 ♀.

As well as the three listed above, the British Museum has specimens of *U. thomasi* from Ras Duqm (19°39′N 57°42′E), Al Ajaiz (19°32′N 57°12′E) and Masirah Island, and a series collected by W. Thesiger 'between Bawi and Salalah'. This material is quite uniform and shows that females like males, have femoral pores, although often reduced. Adults are fairly evenly coloured but juveniles are very strikingly marked (see Plates 15–16). Stomach contents indicate that, like other *Uromastyx*, *U. thomasi* is essentially vegetarian when adult. It appears to replace *U. microlepis* in the rather less severe dry country nearer the coast and to occupy a range of quite hard open substrates in which it digs burrows. *U. thomasi* has a very peculiar tail that is short, dorsoventrally flattened and almost round in outline so that it is essentially disc-shaped, although with a spiny upper surface. Observations by T. D. Rogers on Masirah suggest that the tail is used to prevent predators molesting the lizard in its burrow, the organ being turned downwards so that another animal entering behind the lizard will be presented with a spiny surface that effectively blocks further progress. Probably the rather similar tails of *Agama battilifera* (Vaillant, 1882) and *A. taylori* Parker, 1935, are also used in this way; Parker reports that the former at least constructs narrow burrows.

Family CHAMAELEONIDAE: chameleons

Chamaeleo (chamaeleon) arabicus Matschie

Chamaeleon arabicum Matschie, 1893: 27. Type locality: Lahadsch (= Lahej, near Aden).

DISTRIBUTION. South Arabia from Aden to Dhofar.

MATERIAL. Dhofar: BM 98.5.17.1–3, (A. S. G. JAYAKAR), 1 ♂, 2 ♀♀. Khadrafi plateau, 2,000 ft. (620 m): BM 1977.1130, 1 juv. Wadi Sarfait: BM 1976.1451, BM 1977.1131, (MDG), 1 ♀, 1 juv. Salalah: BM 1971.1657 (A. J. RIVERS), BM 1977.1132, BM 1977.1134–38, 4 ♂♂, 2 ♀♀. Wadi Nihaz: BM 1930.6.30.15–16, (BT), 1 ♂. Above Ain Arzat: BM 1977.1128, 1 ♂. Milwah Alaud: BM 1931.7.15.57, (BT), 1 ♂. Ayun: BM 1977.1129, BM 1977.1133, 1 ♂, 1 juv.

Hillenius (1966) recognised three taxa of chameleons in Arabia: *Chamaeleo chamaeleon orientalis* Parker, 1938 (south-west Arabia from the Taif area in the north to Rada in south-east Yemen), *C. c. arabicus* (Aden eastwards to Dhofar) and *C. calyptratus* A. Duméril, 1851 (Yemen Arab Republic and neighbouring South Yemen). He regarded the type of *C. calcarifer* Peters, 1871 which is believed to come from south-west Arabia, as a hybrid between the latter species and *C. chamaeleon arabicus*. There seems no doubt that *C. calyptratus* is a good species for, although the other two forms occur within 80 km of its range, it is easily distinguishable on the basis of a number of features including its very high parietal crest, small occipital flaps, long gular and ventral crests and frequent pattern of vertical bars; the anterior neural spines are also distinctly elongated in males which, unlike those of *C. c. orientalis*, have spurs on the hind feet. *C. c. orientalis* is generally similar to the *C. chamaeleon* populations in north Africa and south-west Asia. Parker (1938) described it as a separate subspecies because his material differed in several features from three specimens of *C. chamaeleon* he examined from the Suez area, the vicinity of the type locality of *C. c. musae* Steindachner, 1900, and the nearest *C. chamaeleon* locality to those whence his *orientalis* came. However, *C. chamaeleon* shows considerable local variation within its large range (see for instance Hoofien, 1964, for Palestine) and, if *C. c. orientalis* is compared with a larger selection of northern *C. chamaeleon*, its supposed distinctive features largely disappear. Thus head shape is quite variable and the head proportions that Parker assigns to *orientalis* occur elsewhere, as does an arched parietal crest; scales on the occipital crest are often rather flat and large in *orientalis* but they are sometimes raised and often quite small, as is normal in *C. chamaeleon*; finally, transversely enlarged granules on the mid-line occur in several other areas in the range of *C. chamaeleon*. The distinctiveness of *C. c. orientalis* is thus by no means proven and must await a detailed intraspecific study of *C. chamaeleon*.

C. c. arabicus differs from the populations assigned to *C. c. orientalis* in its higher crest, the usual presence of conical tubercles along the edges of the occipital lobes and the presence of spurs on the hind feet of males. It is also mainly a lowland form whereas all known *C. c. orientalis* localities (Taif area, Abha, Sana'a, Rada) are above 1,300 m. The two taxa are not known to contact each other, their nearest localities (Rada for *C. c. orientalis* and Lahej near Aden for *C. c. arabicus*) being more than 160 km apart but, as each is quite uniform over distances of well over 800 km, any intergradation is likely to be quite abrupt. Furthermore, *C. c. arabicus* is as distinct from the nearest

known *C. c. orientalis* populations as some full species, such as *C. africanus* Laurenti, 1768, are. Possibly further collecting in South Yemen will enable the status of the form to be decided.

Hillenius (*ibid*) records *C. c. arabicus* from south of Muscat but this is based on a single specimen with very vague data (BM 97.11.15.2). The alleged occurrence of this form on Masirah is likely to be due to introduction from Salalah (S. Moult and T. D. Rogers, pers. comm.) and its certain range does not extend east of Dhofar.

In Dhofar, chameleons are widespread up to about 650 m in the more mesic areas but are most abundant in irrigated plantations and gardens. Elsewhere they occur in grassland, with or without bushes, in low vegetation on beaches and sometimes in rocky wadis. Although usually spending much of their time in bushes, chameleons are frequently seen on the ground, occasionally some metres from plants, and can progress quite efficiently over earth or rock surfaces. At Wadi Darbat a male was seen pursuing a female across the ground at dusk. When captured, these chameleons are aggressive and bite readily. One specimen (BM 1971. 1657) was taken from the gut of a *Telescopus dhara*.

Family LACERTIDAE: lacertid lizards
Genus *Acanthodactylus* Wiegmann

This genus of about 25 species is found in dry areas from Spain and Portugal through north Africa and the Middle East to north India. Although forming a conspicuous and important part of the reptile fauna of these regions, the group has required substantial recent revision (Arnold, in prep). Examination of the extensive material in the British Museum, paying especial attention to osteological and genital features, has resulted in the recognition of three previously unnoticed species, which are described below. Differences in genitalia also indicate that some forms usually regarded as races are best treated as full species; this is true of certain populations usually assigned to *A. pardalis* and to the various forms of *A. cantoris* s. lat. Two of the latter are known only from the Arabian area (*A. arabicus* Boulenger, 1918 and *A. schmidti* Haas, 1957) and another, *A. blanfordii* Boulenger, 1918 of Iran, Afghanistan and south-west Pakistan, has recently been discovered around Muscat by M. D. Gallagher. Genital characters have also thrown some light on the

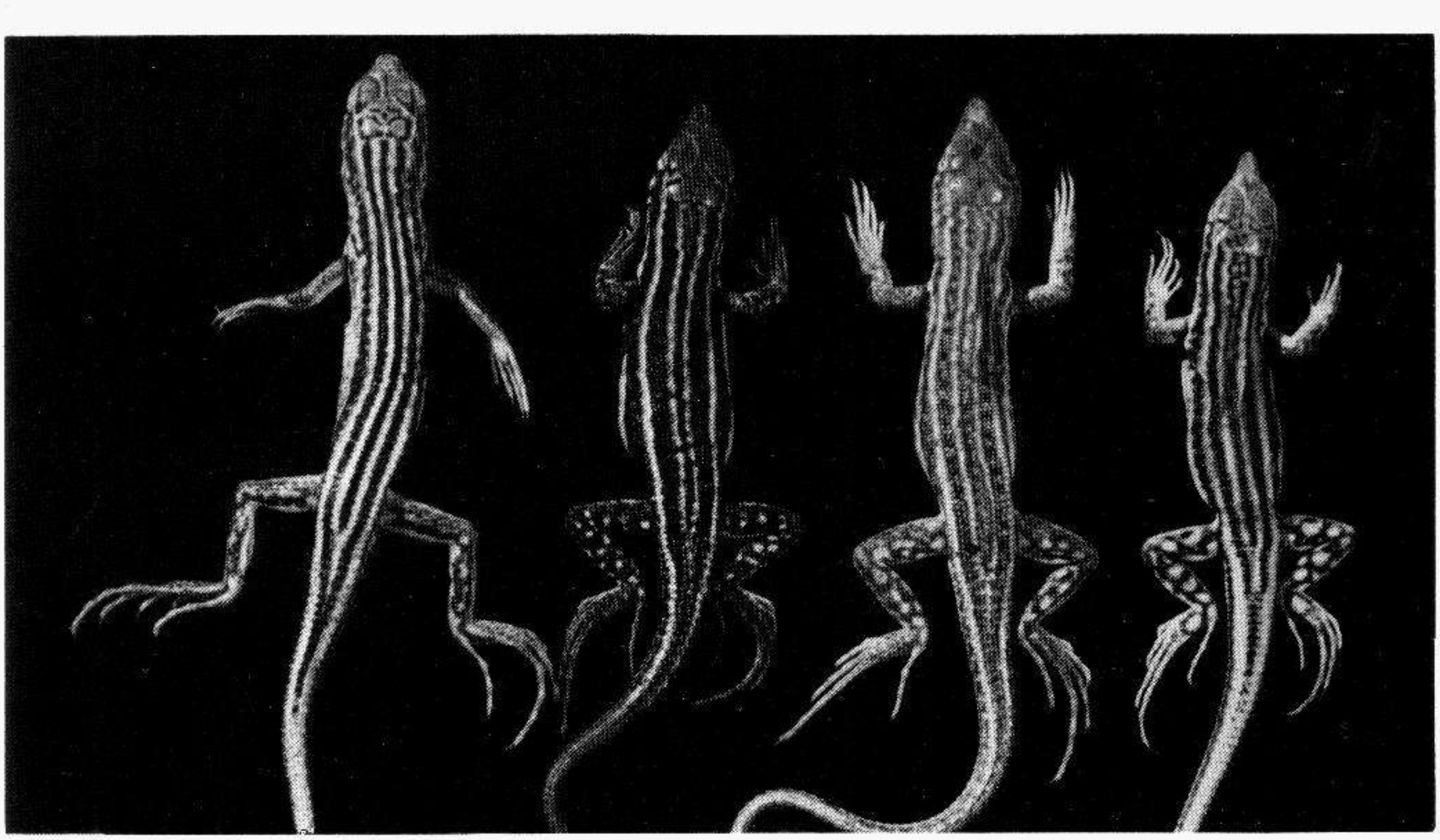

PLATE C. Juveniles of the *Acanthodactylus opheodurus* group. (*Left to right*): *A. opheodurus*, 40 mm from snout to vent, from Jazir coast, BM 1969.315; *A. felicis*, 36 mm, from near Mirbat, BM 1977.1150; *A. felicis*, 37.5 mm, from Ayun, BM 1977.1145; *A. masirae*, 32.5 mm, from Masirah Island, BM 1976.1465.

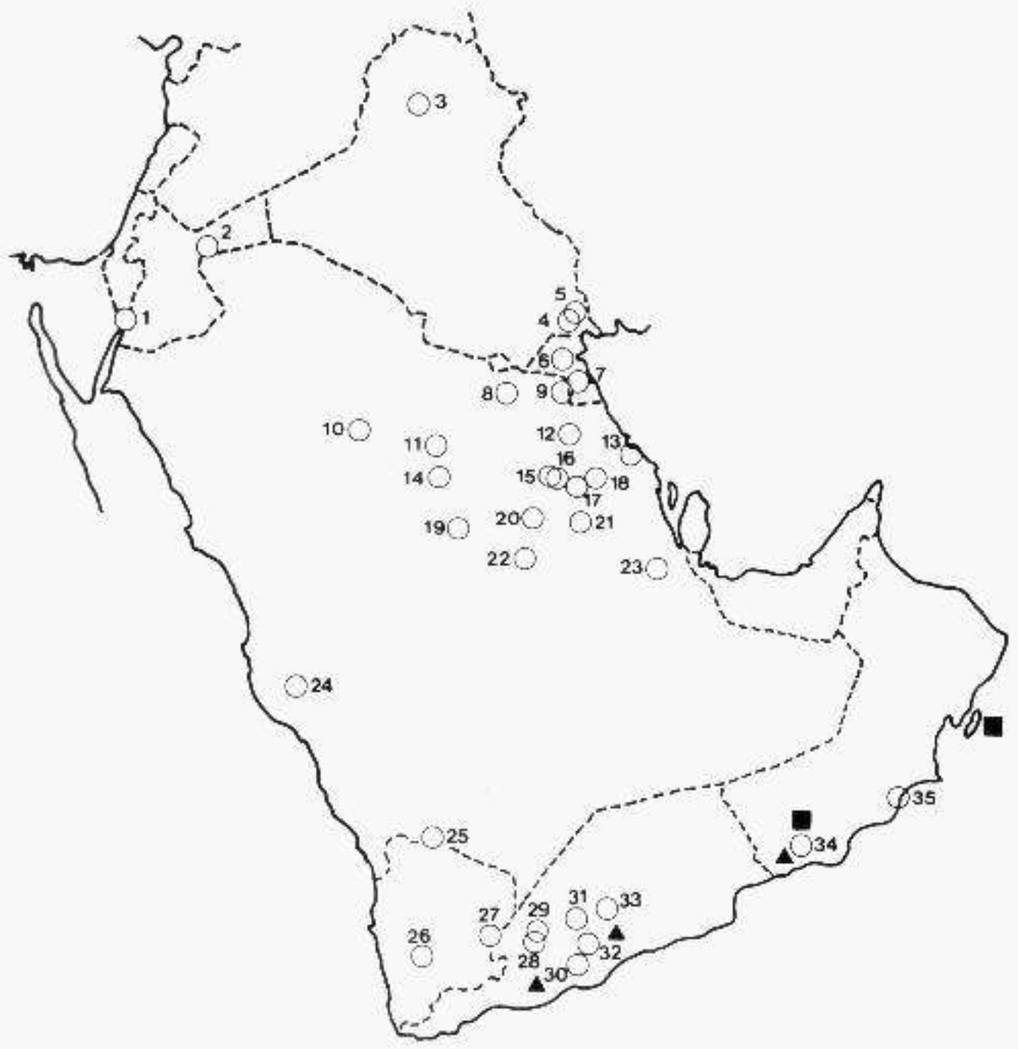

FIGURE 1. Known distribution of members of the *Acanthodactylus opheodurus* group. Circle = *A. opheodurus*; numbers refer to localities as listed; triangle = *A. felicis*; square = *A. masirae*.

confused interrelationships of *Acanthodactylus* species, suggesting for instance that *A. grandis* and the probably conspecific *A. fraseri* are most closely related to *A. schreiberi* and *A. boskianus*, that *A. robustus* is close to *A. tristrami* and that *A. gongrorhynchatus* and *A. haasi* are directly related to Arabian members of the *A. cantoris* group. Genitals and osteology also indicate that *Eremias guineensis* Boulenger, 1887 of West Africa is really an *Acanthodactylus*. The three species described here for the first time form a distinct assemblage within *Acanthodactylus*, which it is proposed to name informally after the most widespread form as the *A. opheodurus* group; the other two are *A. felicis* and *A. masirae*. The terminology for hemipenial structure used here is explained in Arnold (1973).

Acanthodactylus opheodurus sp. nov.

(*Plates 17 and D, also Plate C on p. 295*)

ORIGIN OF NAME. From the Greek *ὀφεώδης*, snake-like, and *οὐρά*, tail; see p. 300.

DISTRIBUTION. Arabia, S Palestine, Jordan and Iraq.

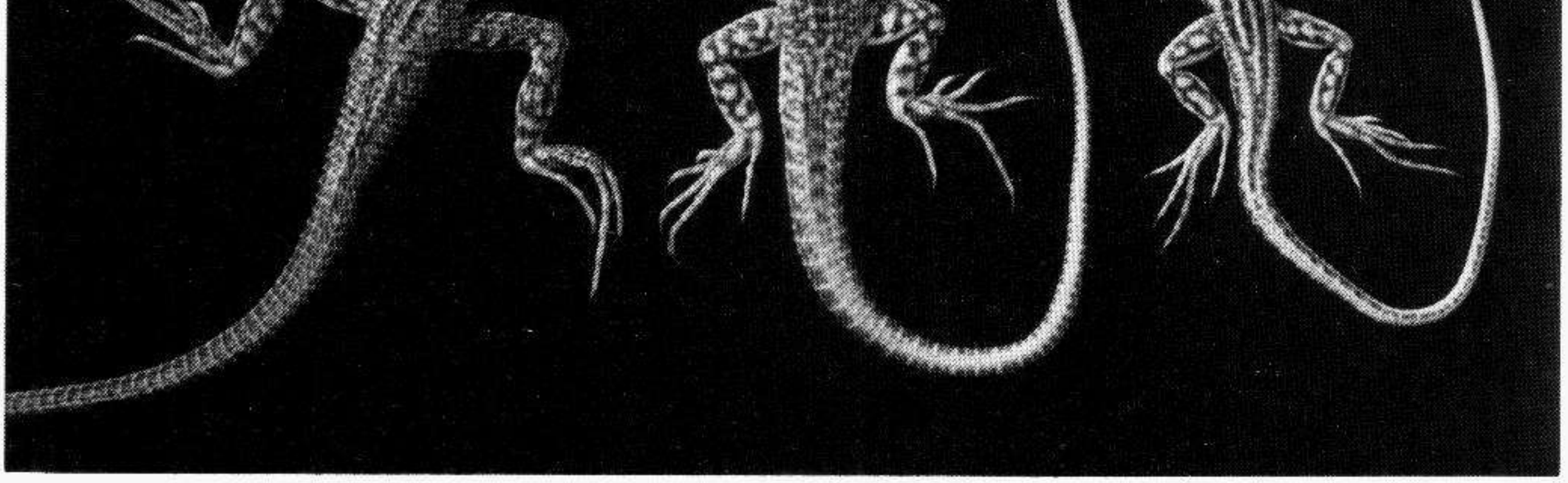

PLATE D. *Acanthodactylus opheodurus* sp. nov., *(left)*: holotype, ♂, 54.5 mm from snout to vent, from Jazir coast; BM 1969.314. *(Centre and right)*: ♀♀, from near Taif, Saudi Arabia; BM 1978.921–22.

MATERIAL. Figures at beginning of each entry refer to distribution map (Fig. 1). *Holotype*. **35.** Jazir coast (18° 40′N 16°40′E), Sultanate of Oman: BM 1969.314 (G. POPOV, 16.2.1968), ♂. *Paratypes* (n = 66). *Palestine*. **1.** Wadi Minaye: BM 1952.1.4.71, (G. HAAS, 20.2.1950), 1 ♂. *Jordan*. **2.** Tell Quarma (31°47′N 37°08′E): BM 1965.691, (S. BISSEROT), 1 ♂. *Iraq*. **3.** Ash Sharqat, Ninevah Province (35°07′N 43°16′E): 1 ♂. **4.** SW of Zubair (30°23′N 47°43′E): BM 1975.1198–99 (Anti-locust Research Centre, 4.3.1946), 1 ♂, 1 ♀. **5.** Basra: BM 1919.12.19.2–3, (C. CHRISTY), 1 ♂, 1♀. *Kuwait*. **6.** Kuwait: BM 1970.1927, (A. D'A. BELLAIRS), BM 1972 360, (K. BLACKWELL), BM 1978.360, 2 ♂♂, 3 ♀♀. **7.** 28°50′N 48°00′E: BM 1964.97, (D. VESEY-FITZGERALD), 1 ♂. *Saudi Arabia*. **8.** 28°30′N 46°00′E: BM 1964.103–107, (D. VESEY-FITZGERALD), 3 ♂♂, 2 ♀♀. **9.** 28°30′N 47°30′E: BM 1964.96, (D. VESEY-FITZGERALD), 1 ♀. **10.** Hail: BM 1963.763, (G. POPOV, 16.3.1962), 1 ♂. **11.** 27°12′N 43°55′E: BM 1964.100–101, (D. VESEY-FITZGERALD), 2 ♂♂. **12.** Quariya (27°33′N 47°40′E): BM 1964.93–94, (D. VESEY-FITZGERALD), 2 ♀♀. **13.** 25°55′N 49°23′E: BM 1976.1706, (D. A. PITCHER), 1 ♂. **14.** Bureidah: BM 1963.768, (G. POPOV, 11.4.62), 1 ♀. **14.** Bir Shari, near Bureidah: BM 1963.767, 1 ♂. **15.** 26°25′N 46°45′E: BM 1964.102, (D. VESEY-FITZGERALD), 1 ♂. **16.** Maagala (26°27′N 47°17′E): BM 1964.91–92, 2 ♂♂, (D. VESEY-FITZGERALD). **17.** 26°18′N 47°56′E: BM 1970.343, (J. P. MANDAVILLE), 1 ♀. **18.** 6 km SE of ad-Dabtiyah (26°26′N 48°36′E): BM 1971. 1346, (J. P. MANDAVILLE), 1 ♀. **19.** Sajir (25°10′N 44°35′E): BM 1974.4137, (T. D. STONER), 1 ♂. **20.** Tauki (25°30′N 46°45′E): BM 1964.89, (D. V. FITZGERALD), 1 ♂. **21.** Jawad Khan, 100 miles (160 km) west of Hofuf: BM 1947.3.2.19, (H. R. P. DICKSON), 1 ♂. **22.** 25 km west of Riyadh: BM 1974. 4136, (T. D. STONER), 1 ♂. **23.** Jafura: BM 1924.11.18.8, (P. Z. COX, R. E. CHEESMAN), 1 ♀. **24.** Taif: BM 1978. 921–22, BM 1978.2267, (J. GASPERETTI), 1 ♂, 2 ♀♀. 'Hejaz' (part of a collection that comes from a range of localities in western Arabia; see Arnold & Leviton, 1977: 224): BM 1938.2.1.54–56, (H. ST.J. B. PHILBY), 2 ♂♂, 1 ♀. **25.** Lower Wadi, Nejran (17°30′N 44°10′E): BM 1963.771, (G. POPOV), 1 ♀. *Republic of North Yemen*. **26.** Jabal Shammar (14°39′N 44°05′E): BM 1963.765, (G. POPOV), 1 ♂. **27.** Harib (15°01′N 45°30′E): BM 1963. 777, (G. POPOV). *Republic of South Yemen*. **28.** Wadi Jardan, near Ayadh (14°59′N 46°51′E): BM 1957.1.15. 37–38, (D. J. GREATHEAD), 2 ♀♀. **29.** Shabwa (15°22′N 47°00′E): BM 1957.1.15.36, (D. J. GREATHEAD), 1 ♂. **30.** Wadi Na'qa (14°24′N 48°18′E): BM 1956.1.7.65, (D. HALL), 1 ♀. **31.** Ghouda (= Qa'udha, 15°45′N 48°18′E): BM 1956.1.7.67, (D. HALL), 1 ♀. **32.** Wadi Ain (15°00′N 48°40′E): BM 1956.1.7.67, (R. HALL), 1 ♂. **33.** Seyun (15°56′N 48°47′E): BM 1953.1.7.28, (G. POPOV), 1 ♂. 'Hadhramaut' (collected on T. Bent's 1893–4 expedition to Hadhramaut, these specimens may have been taken in Wadi Hadhramaut itself between Haynin and Shibam or possibly on the route from Mukkala, or on the way back to the coast at Shihr): BM 97.3.11.66–70, (J. ANDERSON), 2 ♀♀, 3 juv. 'East Aden Protectorate': BM 1957.1.15.39–40, 2 ♀♀. *Sultanate of Oman*. **34.** 16 km S of Thamarit, Dhofar: BM 1977.1155–60, (E. N. ARNOLD), 2 ♂♂, 3 ♀♀, 1 juv. **35.** Jazir coast: BM 1969. 315, (G. POPOV, 16.2.68), 1 juv. (Holotype also from this location.)

DIAGNOSIS. A relatively small species of moderate build with a fairly pointed snout, supraocular scales often intact (although first and fourth may be broken into a number of sections), subocular nearly always separated from lip, usually four but occasionally five upper labial scales anterior to subocular. Dorsal scales coarse, keeled and imbricate posteriorly, 25–38 at mid-body, 8–12 between hind legs, flank scales smaller than mid-dorsals; ventral scales arranged in straight lines, a maximum of 10 or 11 across belly; usually three rows of scales on fingers but indications of an irregular fourth row occasionally present and subdigital lamellae with one or more keels; pectination on toes moderate. Juveniles with a usually simple mid-dorsal stripe formed from the occipital bands, two or three pairs of lateral stripes and a red-pigmented tail; adults often retain mid-dorsal stripe but other stripes may become broken up or replaced by dappling. Premaxilla not abruptly narrowed, typically 24 or 25 presacral vertebrae in males and 25 in females, fifth sternal rib usually intact. Hemipenis with a single lobe, medial section of armature absent or reduced to a thread, lateral clavula flat but edges folded upwards.

Differs from sympatric *A. boskianus*, with which it is often confused, in smaller adult size, single-lobed hemipenis lacking medial section of armature, shorter head, usually simple mid-dorsal stripe, range of adult patterns and, in most of Arabia, a higher number of dorsal scales at mid-body. For distinction from the similar *A. felicis*, see p. 301.

DESCRIPTION OF HOLOTYPE. A mature male preserved in alcohol; in good condition but tail tip damaged, a cut on left side of belly and left hemipenis removed.

Moderately built with a distinctly depressed body. Head length (from snout tip to posterior edge of squamosal bone located without breaking the skin) less than twice the maximum width at the jugal bones and about 1.7 times width at the quadrates; approximately 28% of total snout-vent distance. Snout pointed but not very narrow; perinarial regions slightly but distinctly swollen; canthus strong and loreal region distinctly concave; a slight but distinct median depression running from the frontonasal to the anterior frontal; pileus about twice as broad as long. Limbs quite slender, foot about 1⅓ times head length; tail somewhat dorsoventrally flattened proximally, becoming slightly laterally compressed distally; length about twice snout-vent distance.

Rostral shield not especially prominent; paired internasals meet behind this shield their common suture about $\frac{1}{16}$ length of the frontonasal which is hexagonal and about as long as broad, its greatest width being somewhat more than the internarial distance measured at the centre of the nostrils. Prefrontals longer than broad with a common suture of about $\frac{2}{5}$ of their length. Frontal distinctly shorter than the distance from its anterior border to the tip of the snout, obliquely pointed anteriorly, its maximum width being slightly less than half its length; much narrowed posteriorly where its width is about a fifth of the length. Frontoparietals over half length of the frontal with an extensive common suture. Parietals each rather longer than broad, the outer border somewhat sinuous, the posterior margin curving backwards from the midline. Interparietal a small, rounded lozenge with a clear parietal foramen. No occipital scale. Four supraocular scales on each side, the first (which is divided in two on the left) in contact with the frontal and small, although larger than the fourth; 3/1 granules wedged between the outer parts of the third and fourth supraoculars where they meet each other. Supraciliary scales 7/7, the first largest and broadly in contact with the first supraocular; supraciliaries separated from the second and third supraoculars by a continuous row of 13/13 granules.

Nostril bordered anteriorly and dorsally by the internasal, posteriorly by a single postnasal and inferiorly by the first upper labial. First and much larger second loreal both longer than high. Four upper labials anterior to the centre of the eye, the last being longest. Reflexion of the edges of the eyelid quite strong producing a clear serration (not as well developed as in *e.g. A. scutellatus* and *A. schmidti* but much more apparent than in other members of the *A. opheodurus* group). Scales in middle of lower eyelid somewhat enlarged and translucent. Scale in anterior corner of orbit not much enlarged, row of scales running along upper surface of suborbital not prominent, followed by four larger scales, the last of which contacts postocular. Postocular about as high as long, in contact with fourth supraocular, and anterior supratemporal, separated from last supraciliary by granules. Subocular large with a strong keel running forward on to the presubocular, its lower edge obliquely pointed and well separated from the mouth. 3/3 upper labials posterior to subocular. 2/2 supratemporals with keels, all more or less on parietal table of skull, the posterior ones small. Other temporals small and polygonal above becoming often abruptly larger below where they are raised. Tympanic scale moderate, elongate and keeled. 3/2 blunt scales form a fringe on anterior border of ear opening.

7/7 lower labials; five pairs of chin shields, the first three in contact. 28 gular scales in a straight line from symphysis to the mid-line of the collar; anterior ones small and almost juxtaposed but becoming larger, more imbricate and broader posteriorly; no clear gular fold. Collar somewhat serrated, attached in region of mid-line, curved and made up of ten scales.

Scales raised and granular on nape increasing in size posteriorly and becoming flat and broad with very obtusely pointed margins. Here the scales are imbricate and quite strongly keeled. Scales on flanks much smaller although increasing in size towards the ventrals. 23 dorsal scales in a transverse row at mid-body of which about 14 in the middle of the series are large. 10 large dorsal scales in a transverse row between the hind limbs. Ventral plates not strongly imbricate, in regular longitudinal and transverse series; most are broader than long. 10 ventrals in longest series across mid-body and 26 transverse series between the collar and hind legs. Preanal region with two strongly enlarged plates that are expanded transversely, the more posterior more so than the other; these are surrounded by an irregular semicircle of 9 scales which in turn are bordered by smaller ones.

Anterior and dorsal surfaces of upper foreleg covered with large imbricate scales that extend onto anterior and dorsal surfaces of the lower limb but become smaller and keeled posteriorly; rest of limb covered with granular scales. Fingers slightly denticulate, the

first four surrounded by three rows of scales, the fifth by four.

Anterior surface of thigh with a row of very large, imbricate scales, bordered above and below by ones that are smaller and decrease in size posteriorly and, on the dorsal surface, where they are lightly keeled, grade into granules that extend onto the posterior surface. 21/22 femoral pores, the two series meeting on the mid-line and extending quite close to the knee. Upper surface of tibia with large, flat, keeled, pointed, imbricate scales that become smaller distally but are larger, more pointed and carinate towards the outer face of the limb. Underside of tibia with three rows of large scales. Toes covered by three rows of scales, the posterior forming a denticulation stronger than on the fingers and about half the toe diameter. 23/23 unicarinate lamellae beneath fourth toe.

Upper caudal scales much larger than posterior dorsals, obtusely pointed and mucronate with strong keels that form straight lines along tail. Proximal mid-dorsals often broader than long. Ventral caudals smooth; about 20 scales in fourth whorl behind vent.
Colour in spirit. Buff above, although greyer on the nape and the feet tend to be paler. Some grey on sides of head, and three dark spots in subocular region. Dorsum with a pattern of stripes on body: a simple mid-dorsal and three pairs of lateral ones, the first of which contains ocelli and the second is broken up. Hind legs with light spots; underside white.
Size. Snout to vent 54.5 mm; head length 15.2 mm; tail 101 mm, incomplete.

VARIATION IN PARATYPES. Differences mainly due to ontogenetic variation are not mentioned here, except for change in pattern. Head length approximately 26–30% of snout-vent distance in males, 25–28½% in females; canthus especially strong in males; tail 2–2.4 times length of head plus body. Common suture of internasals rather variable in length but usually longer than in holotype, frontonasal may be broader than long or a little less, frontoparietals about half to two-thirds length of frontal, their common suture straight or sinuous, a vestige of occipital scale sometimes present. First supraocular broken into two or three sections in over 30% of individuals, 1–8 (usually 3 or 4) granules wedged between the third and fourth supraoculars, supraciliaries 5–8, supraciliary granules 10–15, the series interrupted in 15% of cases. First loreal occasionally higher than long, second often about as high as long, occasionally five upper labials anterior to centre of eye (2 out of 49 examples), often two large, keeled scales on posterior edge of orbit separated from postocular by two or three granules. Postocular occasionally divided, subocular sometimes reaches lip (2 cases out of 65), supratemporals occasionally 2/1 or 1/1, tympanic scale often quite large, ear denticulation involves 2–6 scales, 6–9 (usually 7 or 8) lower labials, rarely four or six pairs of chin-shields instead of five, 22–33 gular scales (26–30 in 75% of examples), occasionally a faint gular fold, collar with 8–13 (usually 9–11) scales.

Some variation in degree of keeling on dorsals, 25–38 in a transverse row at mid-body, 12–20 of which are enlarged, 8–13 large scales in transverse row between hind limbs. Ventral plates slightly to quite strongly imbricate, usually 10 in longest row across body but occasionally 12 and, in one case out of 54, 8; 25–29 (usually 26 or 27) transverse series in between collar and hind legs in males, 24–29 (usually 25–28) in females. Preanal region with two, occasionally three, enlarged plates on mid-line or sometimes scales fairly small and irregular.

Denticulation on fingers varies in extent and there may be extra scales on the anterior surface, especially in the south. 18–23 femoral pores on each side in males, 17–23 in females, the two series meeting on the mid-line or separated by a single scale. Scaling on tibia somewhat variable.

Young animals are very pale with a bold pattern of very dark longitudinal stripes, the five most central of which are more or less subequal in width. The one on the mid-line which terminates at about the level of the hind legs appears to be derived from the occipital bands and is nearly always simple, not bifurcating on the neck; it is flanked by two or three pairs of stripes: parietal, temporal, and where present, maxillary. The parietals meet and fuse on the tail base, the temporals run along its sides and the maxillaries are usually narrow on the body or absent. The stripes may be solid or contain pale spots, and the limbs are covered with light ocelli or spots which are often confluent.

This pattern shows at least some alteration with growth and the contrast between stripes and ground colour is reduced. On average, females change less than males and sometimes retain the basic pattern of striping. In most other cases, although the central stripe which contains least ocelli remains more or less intact, the parietal and especially the temporal develop more

light enclosures and tend to become broken up, sometimes producing a general reticulation of the flank areas.

Some males are generally similar to females although break-up of the simple juvenile striping is usually more marked. The central stripe may contain large light areas that can be confluent and the replacement of the parietal and temporal bands by reticulation is especially common. In some cases the central stripe disappears and the dorsum may have a general reticulation, or be covered with scattered dark spots that tend to form transverse series, or be generally uniform; in such cases the more lateral stripes may be occasionally retained on the body (especially the maxillary and temporal and the light stripe separating them).

In general, striping is more clearly retained in the south, but there is considerable variation and in some areas the whole pattern is faded in adults (Jabrin, parts of Hadhramaut and in Dhofar). Adults may be pale greyish or buff in life, often with a bronzy gloss. Underside is uniform whitish although in one old male (BM 1964.97) the throat has a dark reticulation. In life a female and young from Dhofar had the distal part and underside of tail bright red with some yellow near the tail base. Females from Taif and an immature female from near Riyadh also apparently had red tails.

Largest examples: ♂ 62 mm, ♀ 60 mm.

GEOGRAPHICAL VARIATION. Head tends to be relatively larger in north, gular counts lower (23–30 (32) compared with 25–33), number of plates in collar higher (8–13 compared with 8–11) and number of dorsal scales across mid-back higher (25–38 compared with 25–35). There is also local variation in the degree of keeling on the dorsals and in the extent of pectination on the toes. Striping tends to be more persistent in some southern populations.

SKELETAL FEATURES. Premaxilla not abruptly narrowed, with about 7 teeth; postorbital and postfrontal bones separate; usually 24 or 25 presacral vertebrae in males (23–1, 24–6, 25–4) and 25 in females (24–2, 25–11, 26–1); fifth sternal rib usually intact.

HEMIPENIS. See diagnosis, p. 297.

ECOLOGY. There is little direct evidence on the habitat requirements of this species. Specimens from Dhofar (BM 1977.1155–60) were taken in a flat area with a relatively hard sand substrate and small dense bushes on hummocks; they occurred alongside *A. boskianus*. The moderate pectination of the digits and fringing of the eyelids in *A. opheodurus* suggest that it is a form neither of really soft-sand habitats nor of the quite hard surfaces favoured by some *Acanthodactylus*; local variation in these morphological features may also indicate that its substrate niche is not very strict. The fact that it is not known from the large acolian sand areas of inland southern Arabia also supports the view that it avoids soft sand.

The Dhofar specimens took refuge at the base of bushes when disturbed. They also had the singular habit of wriggling their often brightly coloured tail laterally, and sometimes waving it too, as they stopped after running.

Acanthodactylus felicis sp. nov.

(*Plates 18 and E, also Plate C on p. 295*)

ORIGIN OF NAME. From the classical term for southern Arabia, *Arabia Felix*.

DISTRIBUTION. South Yemen and Dhofar; see Fig. 1.

MATERIAL. *Holotype*. 'Hadhramaut', Republic of South Yemen (collected on T. Bent's 1893–4 expedition to Hadhramaut, this specimen may have been taken in Wadi Hadhramaut itself between Haynim and Shibam or on the way back to the coast at Shihir): BM 97.3.11.65 (J. ANDERSON), ♂. *Paratypes* (n = 13). Mafad (14°03′N 46°55′E), Republic of South Yemen: BM 1963.782, (G. POPOV, 22.10.1962), 1 ♀. Between Salalah and Mukallah: BM 1974.4040–41, (W. THESIGER, 3.3.–14.4.47), 2 ♀♀. Ayun: BM 1977.1142–47, (E. N. ARNOLD), immature ♂ and ♀, 4 juv. 49 km from Salalah on Thamarit road: BM 1977.1154, (E. N. ARNOLD), 1 juv. Wadi Anshayr, east of Mirbat (17°00′N 54°45′E): BM 1977.1148–50, 2 ♂♂, 1 juv.

DIAGNOSIS. A relatively small species of *Acanthodactylus* (up to 62 mm from snout to vent) of moderate build with a fairly pointed snout, supraocular scales often intact (although first and fourth may be broken into two or more sections), subocular separated from lip, four upper labial scales anterior to subocular. Dorsal scales coarse, keeled and imbricate posteriorly, 33–42 at mid-body, 9–12 between hind legs, flank scales smaller than mid-dorsals; ventral scales arranged in straight lines, usually a maximum of eight across belly (rarely 10); three rows of scales on fingers, their subdigital lamellae unicarinate; pectination on toes moderate. Juveniles with a mid-dorsal stripe formed from the

occipital bands which bifurcates anteriorly, usually three pairs of lateral stripes and a blue tail; adults may retain this basic pattern or it may become broken up. Premaxilla not abruptly narrowed, typically 24 presacral vertebrae in males and 25 in females, fifth sternal rib usually intact. Hemipenis with a single lobe, medial section of armature absent or reduced to a thread, lateral clavula flat but edges folded upwards.

Differs from sympatric *A. boskianus* in all the features that distinguish *A. opheodurus* from this species listed on p. 297 except the usual form of the mid-dorsal stripe. Separable from *A. opheodurus* by a usually lower transverse ventral scale count, bifurcating mid-dorsal stripe and blue tail in young and sub-adults; also mid-body dorsal scale count tends to be higher, scales on tibia smaller and mid-dorsal scales on tail base are usually not clearly expanded.

DESCRIPTION OF HOLOTYPE. A mature male preserved in alcohol; in good condition but tail rather shrivelled.

Moderately built with a somewhat depressed body. Head length (from snout to posterior edge of squamosal bone located without breaking the skin) less than twice the maximum width at the jugal bones and less than twice the width at the quadrates; approximately 31% of total snout–vent distance. Snout pointed but not very narrow; perinarial regions slightly swollen; canthus quite strong and loreal region distinctly concave; a rather weak median depression running from the frontonasal to the anterior frontal; pileus about twice as broad as long. Limbs quite slender, foot about 1¼ times head length; tail somewhat dorsoventrally flattened proximally, becoming slightly laterally compressed distally; length about 2.45 times snout-vent distance.

Rostral shield not especially prominent; paired internasals meet behind this shield, their common suture about ¼ the length of the frontonasal which is hexagonal and distinctly broader than long, its greatest width being clearly more than the internarial distance measured at the level of the centres of the nostrils. Prefrontals longer than broad with a common suture clearly over half their length. Frontal distinctly shorter than the distance from its anterior border to the snout tip, obliquely pointed anteriorly, its maximum width being over half its length; much narrowed posteriorly where width is about a quarter of the length. Frontoparietals over half the length of the frontal with an extensive common suture. Parietals each slightly longer than broad, the outer border almost straight and the posterior margin sloping backwards from the mid-line. Interparietal a small, rounded lozenge with a clear parietal foramen. No occipital scale. Four supraocular scales on each side; the first in contact with the frontal and small but larger than the fourth (the left hand one of which is divided); a small scale wedged between the outer parts of the third and fourth supraoculars where they meet each other. Supraciliary scales 5/5, the first largest and broadly in contact with the first supraocular; supraciliaries separated from the second and third supraoculars by a continuous row of 12/13 granules.

Nostril bordered anteriorly and dorsally by the internasal, posteriorly by a single postnasal and inferiorly by the first upper labial. First loreal as high as long, second loreal much larger and longer than high. Four upper labials anterior to the centre of the eye, the last being longest. Reflexion of the edges of the eyelid weak and not producing a clear serration. Scales in middle of lower eyelid somewhat enlarged and translucent. Row of scales running around lower edge of orbit from anterior corner along the upper surface of subocular not prominent, followed by two larger scales which are separated from the postocular by two smaller ones. Postocular somewhat higher than long, in contact with fourth supraocular, parietal and anterior supratemporal scales, separated from the last supraciliary by granules. Subocular large with a clearly defined keel running forward on to the pre-subocular, its lower edge obliquely pointed and well separated from the mouth. 3/3 upper labials posterior to subocular. 2/1 supratemporals with relatively weak keeling, all more or less on parietal table of skull, the posterior one on the left side small. Other temporals raised and granular, the upper ones small and polygonal, grading gradually into larger ones ventrally that are somewhat elongate anteriorly. Tympanic scale large, elongate but not clearly keeled. 2/2 blunt scales form a fringe on anterior border of ear opening.

7/7 lower labials; five pairs of chin shields, the first three in contact. 36 gular scales in a straight line from symphysis to the mid-line of the collar; anterior ones small and almost juxtaposed but becoming larger, more imbricate and broader posteriorly; no clear gular fold. Collar somewhat serrated, attached in region of mid-line, curved and made up of nine scales.

Scales raised and granular on nape, increasing in size posteriorly and becoming flat and broad, with rounded

or very obtusely pointed margins. Here the scales are more imbricate and less strongly keeled than in *A. masirae*. Scales on flanks much smaller although increasing in size towards the ventrals. 33 dorsal scales in a transverse row at mid-body of which about 16 in the middle of the series are large. 10 large dorsal scales in a transverse row between the hind limbs. Ventral plates rather more imbricate than in *A. masirae*, in regular longitudinal and transverse series; most are broader than long. 10 ventrals in longest series across body, although only 8 more or less complete longitudinal rows; 24 transverse series between the collar and the hind legs. Preanal region with two strongly enlarged plates that are expanded transversely, the posterior more than the other; these are surrounded by an irregular semicircle of eleven scales, with more, smaller ones at each side.

Anterior, dorsal and much of posterior surfaces of upper foreleg covered with large imbricate scales that extend on to the anterior and dorsal surfaces of the lower limb but here become smaller and keeled posteriorly; rest of limb covered with granular scales. Fingers slightly denticulate, the first four surrounded by three rows of scales, except at their bases where, like the fifth finger, they have four rows.

Anterior surface of thigh with a row of very large, imbricate scales, bordered above and below by ones that are smaller and decrease in size posteriorly and on the dorsal surface, where they are lightly keeled, grade into granules. 22/21 femoral pores, the two series meeting on the mid-line and extending closer to the knee than in *A. masirae*. Upper surface of tibia covered with relatively small, flat, imbricate scales that have rounded edges and are lightly keeled; these decrease in size distally but on outer aspect of limb become more pointed and more heavily keeled. Underside of tibia with about three rows of large scales. Toes covered by three rows of scales, the posterior one forming a denticulation stronger than that on fingers but considerably less than half the width of the toe diameter. 22/22 unicarinate lamellae beneath fourth toe.

Upper caudal scales much larger than posterior dorsals, obtusely pointed and mucronate with keels that form straight lines along tail. Proximal mid-dorsals not obviously broader than long. Ventral caudals smooth; about 21 scales in fourth whorl behind vent.

Colour in spirit. Pale grey buff above but feet paler. Sides of snout with some dark grey markings and three dark bars in the subocular region of which the last two are more intense. Dorsum with a weak pattern of stripes which are broken into series of dark spots and blotches; the two occipitals on neck join on hind back. Hind legs with light spots, underside white. *Size*. Snout to vent 52.5 mm; head length 15.2 mm; tail 128 mm.

VARIATION IN PARATYPES. Differences mainly due to ontogenetic variation are not mentioned here, except for change in pattern. Head often smaller and narrower in females and subadults, depression of snout may be stronger than in the type (Mahfad), common suture of internasals $\frac{1}{8} - \frac{1}{3}$ length of frontonasal which may be as long or longer than broad, suture between prefrontals sometimes less than half their length, outer margins of parietals may be concave, first supraocular sometimes divided (Mirbat, Mahfad), supraciliaries up to 8, supraciliary granules 12–15, eyelid serration may be quite strong (Mirbat, Mahfad), some variation in scales bordering lower rim of orbit, postocular occasionally in contact with last supraciliary, supratemporals usually 2/2 and sometimes strongly keeled, ear denticulation varies in development and may involve up to six scales, 7 or 8 upper labials, 26–34 gular scales, occasionally a very weak gular fold, collar with 7–9 scales.

Keeling on dorsals may be marked (Mahfad and to a lesser extent Mirbat) or their imbrication weak (Ayun), 34–42 at mid-body, 14–18 of which are enlarged, 9–12 large scales in a transverse row between hind limbs. Imbrication of ventrals varies (least at Ayun and Mahfad) usually 8 in longest row across body but 10 in one example from Mirbat, transverse series between collar and hind legs 24–29. Preanal region with one to three enlarged plates on mid-line and sometimes two semicircles of small scales. Femoral pores 20–25 on each side in males, 18–23 in females, the two rows in contact on mid-line or separated by a single scale, scales on tibia sometimes very weakly keeled, caudals may be strongly mucronate (Mahfad).

Young animal from Mirbat (BM 1977.1150) has bold pattern of dark longitudinal stripes. The one on the mid-line is narrow and appears to be derived from the occipital bands and bifurcates anteriorly; there are also three pairs of lateral stripes (parietal, temporal and maxillary), the first two being broad. Young specimens from Ayun also have this basic pattern but it is faded, the mid-dorsal stripe may be bifurcated as far

back as the mid-body with the inner borders of its branches poorly defined and there may be a vestige of a spinal band on the neck; the parietal and temporal bands are also less broad. With growth, light ocelli may develop within bands which often become faint or break up, especially the temporal.

Largest examples: ♂ 62 mm, ♀ 57 mm.

GEOGRAPHICAL VARIATION. See above. The differences between available samples and their scattered distribution suggest this species may have a disjunct range. Certainly in Dhofar, the two known localities, Ayun and Mirbat, are separated by unsuitable country.

SKELETAL FEATURES. Premaxilla not abruptly narrowed, with about 7 teeth; postorbital and postfrontal bones separate; usually 24 presacral vertebrae in males (24–5, 25–1), 25 (n = 7) in females; fifth sternal rib usually intact.

HEMIPENIS. See diagnosis p. 301.

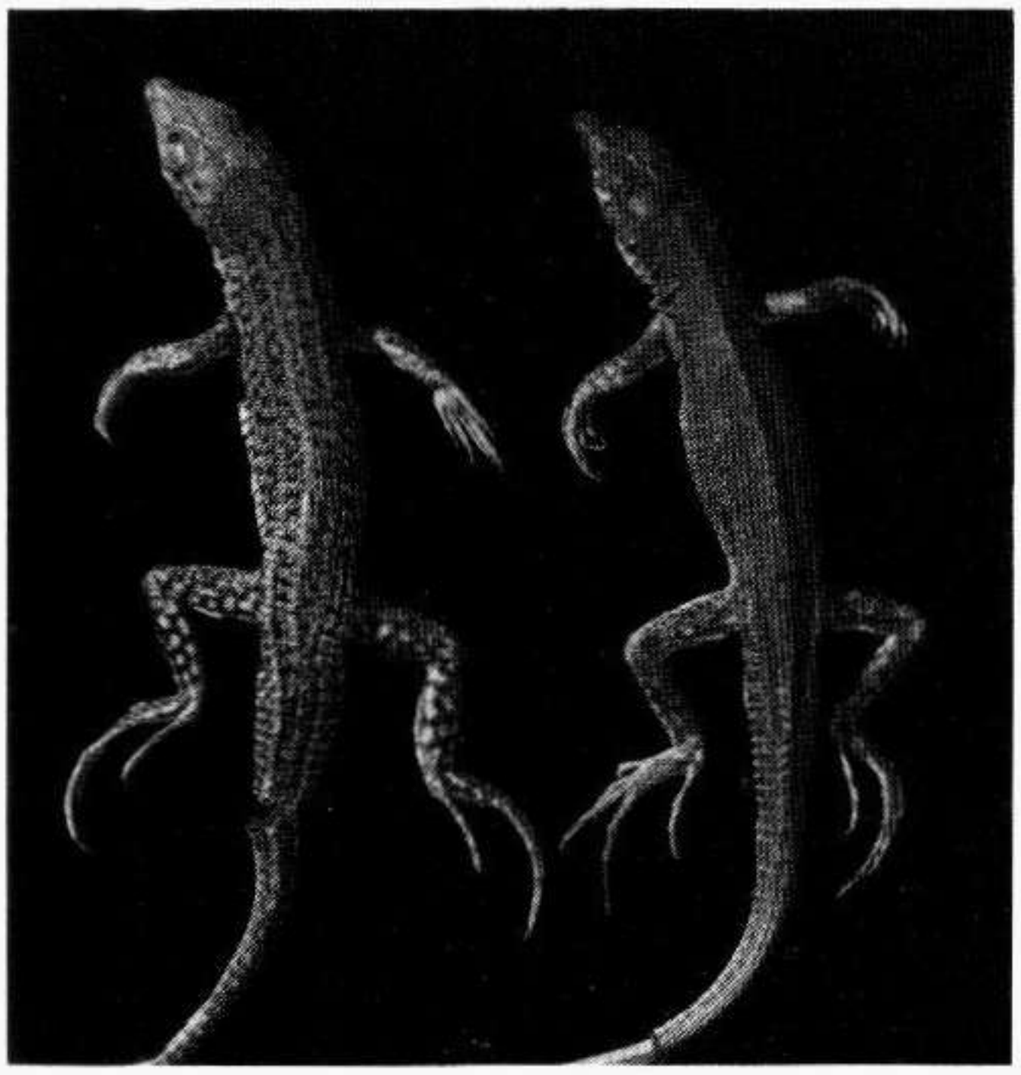

PLATE E. *(Left)*: *Acanthodactylus felicis* sp. nov., holotype, ♂, 52.5 mm from snout to vent from Hadhramaut; BM 97.3.11.65.
(Right): *Acanthodactylus masirae* sp. nov., holotype, ♂, 50.5 mm from snout to vent from Masirah Island; BM 1975.1226.

ECOLOGY. The few records of *A. felicis* are from the largely stony, mountainous country of southern Arabia, but, within this it probably occupies only isolated areas with sandy substrates. In Dhofar, at Ayun, this lizard was common in very shallow sandy wadi beds and their outwashes, and was also found in a rocky hollow with a sand bottom; both these habitats had sparse vegetation. The specimen found 49 km from Salalah on the road to Thamarit was with others in a sandy wadi in rocky country with scattered frankincense trees and those from Mirbat were taken on flat sand among 'scrub'. At all localities this *Acanthodactylus* was replaced on harder substrates by other diurnal lizards (*Mesalina* spp., *Pristurus carteri*, *etc.*). In the Dhofar area, *A. felicis* is apparently replaced by *A. boskianus* and *A. opheodurus* to the north where the country becomes flatter and more continuously sandy and desertic.

Acanthodactylus masirae sp. nov.

(Plate E also Plate C on p. 295)

ORIGIN OF NAME. From the type locality, Masirah Island.

DISTRIBUTION. South-east Arabia from Dhofar to Masirah; see Fig. 1 on p. 296.

MATERIAL. *Holotype*. North point, Masirah Island, Sultanate of Oman: BM 1975.1226 (T. D. ROGERS, 11.8.1975), ♂. *Paratypes* (n = 5). North Point, Masirah Island: BM 1975.2095–96, (T. D. ROGERS, 17 and 26.9.1975), 1 ♂ and juvenile ♀. Jazirat Shaghaf (20°28′N 58°45′E) west of Masirah Island: BM 1975.1039, (T. D. ROGERS, 1.8.1974), BM 1976.1465, (M. D. GALLAGHER, 21.10.1976), 1 ♂ and juvenile ♂. Qarn Shaiba (17°27′ N 54°05′E) 600 m: BM 1930.6.30.14, (B. THOMAS and ALI MUHAMMAD, 9.2.1930), 1 ♀.

DIAGNOSIS. A small species of *Acanthodactylus* (largest known individuals only 52 mm from snout to vent) of moderate build with an acutely pointed narrow snout, supraocular scales intact or fourth divided, subocular bordering lip, three or four upper labial scales anterior to centre of eye. Dorsal scales coarse, keeled and imbricate posteriorly, 31–36 at mid-body, 12–14 between hind legs, flank scales smaller than mid-dorsals; ventral scales arranged in straight lines, a maximum of 10 or 12 across belly; four rows of scales on fingers, although fourth (anterior) row is rather irregular on some digits, subdigital lamellae more or less unicarinate; pectination on toes moderate. Juveniles with a mid-dorsal stripe formed from the occipital bands which bifurcates anteriorly, three pairs of lateral stripes and a blue tail; adults appear nearly uniform above. Pre-

maxilla abruptly narrowed and separated from maxillae by a constriction, 24 presacral vertebrae in males and 25 in females, fifth sternal rib usually intact. Hemipenis with a single lobe, medial section of armature absent or reduced to a thread, lateral clavula expanded and flat but lobed above.

The acutely pointed, narrow snout of this species distinguishes it from nearly all other south Arabian *Acanthodactylus* except *A. gongrorhynchatus* but the latter has the subocular scale separated from lip, a reduced ear opening, finer dorsal scaling, ventrals not abruptly differentiated from dorsals, a more regular fourth scale row on fingers and a narrow clavula.

DESCRIPTION OF HOLOTYPE. A mature male preserved initially in formalin but later transferred to alcohol; rather hard and somewhat shrivelled.

Moderately built with a distinctly depressed body. Head length (from snout tip to posterior edge of squamosal located without breaking the skin) about twice the maximum width at the jugal bones and somewhat less than twice the width at the upper part of the quadrates; approximately 30% of total snout-vent distance. Snout acutely pointed and very narrow (more so than in other *Acanthodactylus* species); perinarial region slightly but distinctly swollen; canthus not very strong and loreal area not clearly concave; a slight but clear median depression running from the frontonasal to the anterior frontal. Pileus about twice as broad as long. Limbs relatively slender, foot about $1\frac{1}{2}$ times head length; tail dorsoventrally flattened and swollen at base but slender distally becoming slightly laterally compressed, length about 2.4 times snout-vent distance.

Rostral shield prominent; paired internasals meet behind this shield, their common suture about $\frac{1}{5}$ length of frontonasal which is hexagonal and rather broader than long, its greatest width being slightly more than the internarial distance measured at the level of the centres of the nostrils. Prefrontals longer than broad with a common suture just over half their length. Frontal distinctly shorter than the distance from its anterior border to the tip of the snout, rounded anteriorly, its maximum width being just over half its length; much narrowed posteriorly where width is less than a quarter of the length. Frontoparietals about half the length of frontal with an extensive, sinuous common suture. Parietals each slightly longer than broad, the outer border slightly sinuous and the posterior margin sloping backwards from the mid-line. Interparietal a small, rounded lozenge with a clear parietal foramen. No occipital scale. Four supraocular scales all intact; the first small, in contact with the frontal but longer than the fourth; a small scale wedged between the outer part of the third and fourth supraoculars where they border each other. Supraciliary scales 6/6, the first largest and broadly in contact with the first supraocular. Supraciliaries separated from the second and third supraoculars by a series of 12/11 granules continuous on the right side but interrupted on the left.

Nostril bordered anteriorly and dorsally by the internasal, posteriorly by a single postnasal and inferiorly by the first upper labial. Loreals both markedly longer than high, the second considerably bigger than the first. Four upper labials anterior to the centre of the eye, the last being longest. Eyelids with reflexed serrated edges but these are not as developed as in *e.g. A. opheodurus*, *A. scutellatus* or *A. schmidti*. Scales in middle of lower eyelid enlarged and somewhat translucent. At anterior corner of orbit an elongate scale followed by a series of smaller scales running along the upper surface of the subocular to meet a large elongate scale just posterior to it which is separated from the postocular by two smaller scales. Postocular higher than long, in contact with last supraciliary, fourth supraocular, parietal and anterior supratemporal. Subocular large with a very clearly defined keel near its upper edge running forwards onto pre-subocular; its lower edge bordering mouth quite extensively ($\frac{1}{4}$ length of upper border). 4/3 upper labials posterior to subocular, 2/2 quite strongly keeled supratemporals, the anterior over three times the length of the other; both are situated on the parietal table of the skull. Other temporals raised and granular, the upper small and polygonal, the lower larger and rather elongate. Tympanic scale large, long and keeled. 6/4 scales form a well marked, denticulated fringe along the anterior ear opening; fourth scale of series is longest.

8/8 lower labials; five pairs of chin shields, the first three in contact. 31 gular scales in a straight line from symphysis to the mid-line of the collar; anterior ones are small and almost juxtaposed but gradually becoming larger, imbricate and broader posteriorly; no clear gular fold. Collar somewhat serrated, attached in region of mid-line, curved and made up of ten scales.

Scales raised and granular on nape, increasing in size posteriorly and becoming flat, keeled, broad and imbricate on hind back with rounded or pointed margins

PLATE 1. *Bunopus spatalurus spatalurus*, ♀, 66 mm from snout to vent, from 16 km south of Thamarit; BM 1978.1095. (Photograph British Museum (Natural History), P. A. Richens)

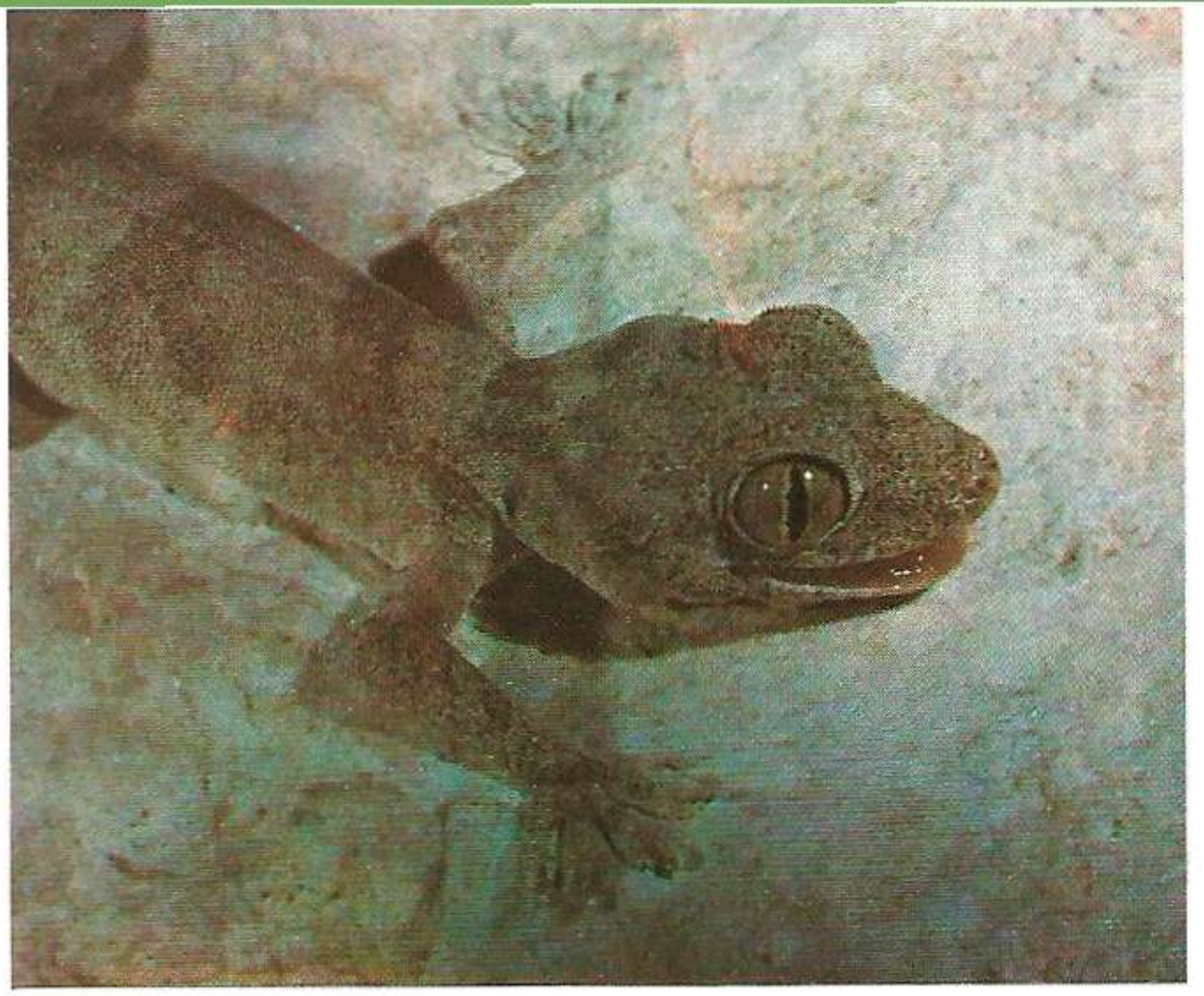

PLATE 4. *Hemidactylus lemurinus* sp. nov., adult at Ayun.

PLATE 2. *Hemidactylus homoeolepis*, ♂, 35 mm from snout to vent, from Khawr Sawli; BM 1977.935.

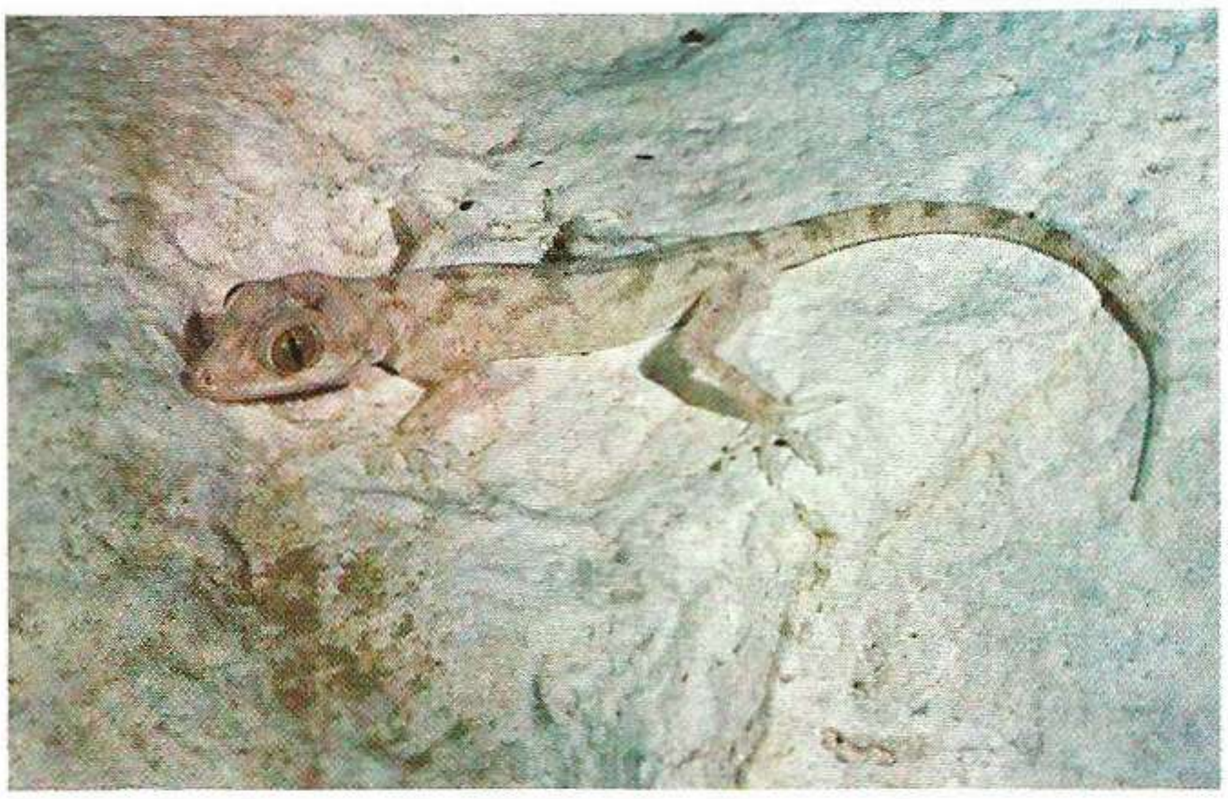

PLATE 5. *Hemidactylus lemurinus* sp. nov., juvenile, 31 mm from snout to vent, at Ayun.

PLATE 3. *Hemidactylus homoeolepis*, ♀, 34 mm from snout to vent, from Khawr Sawli; BM 1977.931.

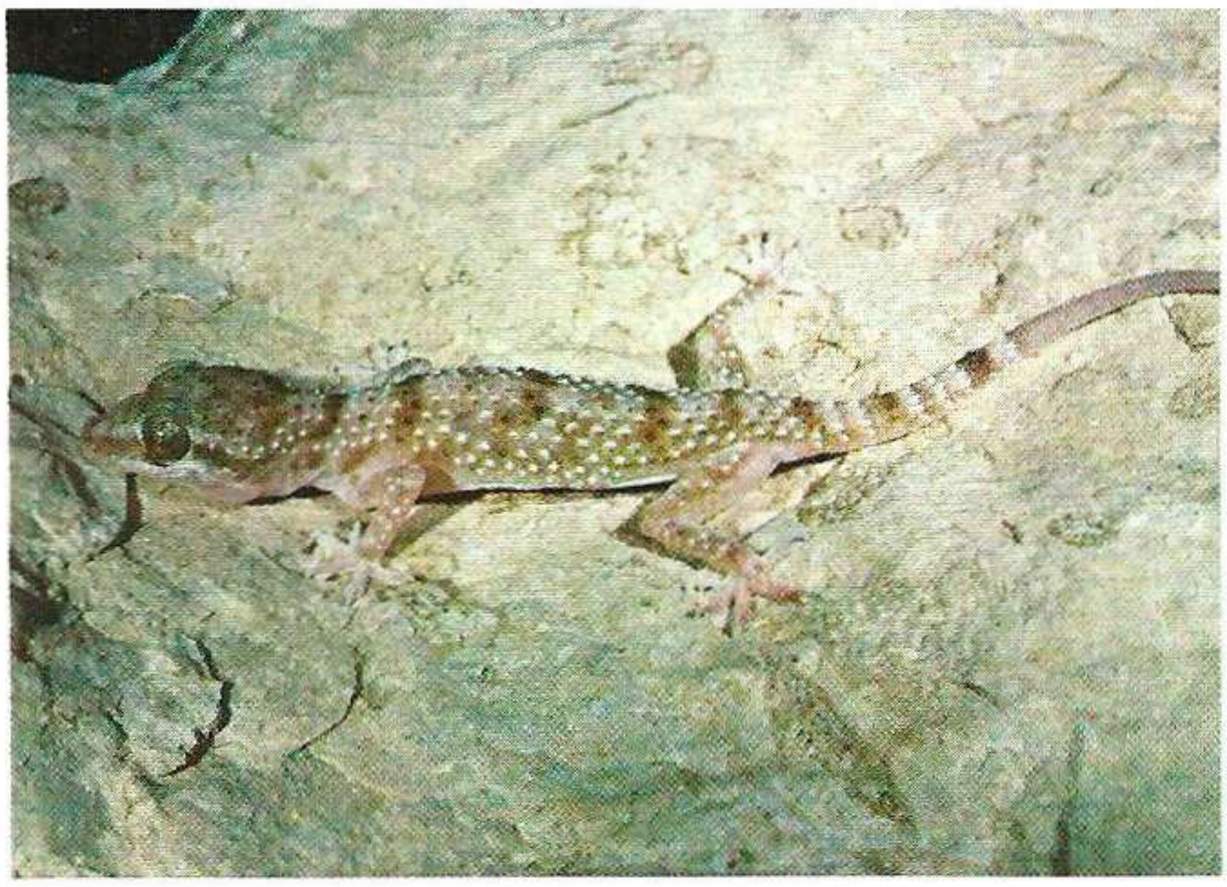

PLATE 6. *Hemidactylus yerburii*, ♀, 54 mm from snout to vent with end of tail regenerated, from Ayun; BM 1977.976.

but not mucronate. Scales on flanks considerably smaller although size increases towards the anterior ventrals. 31 dorsal scales in a transverse row at mid-body of which about 17 in the middle of the series are enlarged. 12 large scales in a transverse row between the hind limbs. Ventral plates with some imbrication, in regular longitudinal and transverse series, at least posterior to thorax; in the median six longitudinal rows most scales are broader than long. 10 ventrals in longest series across mid-body and 26 transverse series between the collar and hind legs. Preanal region with two strongly enlarged plates that are expanded transversely, the posterior more than the other; these are surrounded by an irregular semicircle of 8 scales which, in turn, are bordered by smaller ones.

Anterior, dorsal and part of posterior surfaces of upper foreleg covered with large imbricate scales that extend on to the anterior surface of the lower limb but become rather smaller on its dorsum and keeled posteriorly; rest of limb covered with granular scales. Fingers markedly denticulate. First and second fingers with three rows of scales around them proximally but four near their tips, third to fifth toes with four rows throughout their length although the anterior row is somewhat irregular on toe three.

Anterior surface of thigh with a row of very large imbricate scales that extend onto ventral surface but become smaller posteriorly; rest of thigh granular. 21/20 femoral pores, the two series being separated by a single scale on the mid-line and extending almost to the knee. Upper surface of tibia with relatively small, keeled, pointed, overlapping scales that reduce in size distally; on the outer aspect of the limb they become more pointed and more heavily keeled. Underside of tibia with four longitudinal rows of large scales. Toes covered by three longitudinal rows of scales, the posterior one forming a clear denticulation stronger than that on the fingers but only half as wide as the diameter of the toe. 24/24 unicarinate lamellae beneath the fourth toe.

Upper caudal scales much larger than posterior dorsals, very obtusely pointed and mucronate with keels that form straight lines along tail. Some proximal mid-dorsals broader than long. Ventral caudals smooth; about 23 scales in fourth whorl behind vent. *Colour in spirit*. Uniform grey buff above but feet paler and tail a warmer colour distally. Sides of snout with grey markings that form irregular bars in the subocular region; hind limbs with light spots. Underside dirty pale cream, ventral surface of tail whitish.
Size. Snout to vent 50 mm; head length 15 mm; tail 119 mm.

VARIATION IN PARATYPES. Differences mainly due to ontogenetic variation are not mentioned except for change in pattern. BM 1975.1039, the best preserved in form, has clearly convex cheeks. Frontonasal may be slightly longer than broad; BM 1975.2095 has a small azygos shield between the prefrontals, the suture between which may be more or less than half their length, frontal width usually over half length but less in BM 1930.6.30.14, frontoparietals may be slightly more or less than half the frontal length, prefrontals may be slightly shorter than long and in one case there is a small shield just behind interparietal, fourth supraocular divided in two in some cases and there may be up to three granules wedged between third and fourth supraoculars, supraciliaries 5 or 6, supraciliary granules 12–15, large scale in anterior corner of orbit often absent, as is the one following subocular, postocular sometimes separated from parietal, lower subocular border $\frac{1}{5}$–$\frac{1}{3}$ of upper, tympanic scale may be small, ear denticulation involves up to six scales, 3 or 4 upper labials anterior to subocular, 8–9 lower labials, 29–34 gular scales, collar with 8–12 scales.

31–36 dorsals at mid-body, 17–21 of which are enlarged, 12–14 large scales in transverse row between hind limbs. Ventrals usually 10 in longest row across body but 11 in one and 12 in another example, 26 transverse rows in four males, 29 and 30 in two females, 5–11 scales around enlarged preanal plates. Femoral pores 20–22 on each side.

Juvenile (BM 1976.1465) is pale with a bold pattern of very dark longitudinal stripes. The one on the mid-line appears to be derived from the occipital bands and bifurcates anteriorly; there are also three pairs of lateral stripes (parietal, temporal and maxillary) as in many *A. opheodurus*. Other specimens are formalin-darkened except the adult type which lacks dorsal markings.

Largest examples (♂ and ♀) 52 mm.

SKELETAL FEATURES. Premaxilla abruptly narrowed, with about 7 teeth; postorbital and postfrontal bones separate; 24 presacral vertebrae in males (n=4) and 25 in females (n = 2); fifth sternal rib usually intact.

HEMIPENIS. See diagnosis, p. 304.

ECOLOGY. The few species available come from near sea level (Masirah) and about 600 m (Qarn Shaiba).

The Masirah animals were found on loose sand on low dunes and hummocks and on flatter areas of sand with stones; in at least some cases low vegetation was present and the animals took refuge in holes. The diet includes ants.

Acanthodactylus boskianus (Daudin)

Lacerta boskianus Daudin, 1802: 188. Type locality: Egypt.

DISTRIBUTION. North Africa; Arabia northwards to Turkish border.

MATERIAL. 13–16 km S of Thamarit: BM 1977.1139–40, BM 1977.1151–53, 1 ♂, 3 ♀♀, 1 juv. 7 km E of Ayun: BM 1977.1141, 1 ♂.

Like other Arabian *A. boskianus*, these animals correspond to the most widespread of the presently recognised subspecies, *A. b. asper* Audouin, 1802. As over much of the peninsula, Dhofar *A. boskianus* are much larger than individuals occurring in north Africa and elsewhere. The area of large body size corresponds more or less to the region where *A. boskianus* co-exists with *A. opheodurus* and it seems possible that it represents a character displacement enabling *A. boskianus* to reduce direct competition with the smaller *A. opheodurus* by taking larger prey when adult.

Acanthodactylus schmidti Haas

Acanthodactylus cantoris schmidti Haas, 1957: 72. Type locality: Dhahran, Saudi Arabia.

DISTRIBUTION. Arabian peninsula north to Jordan but absent from much of west, south-west and the Batinah.

MATERIAL. Haylat Ash Shisur: BM 1930.6.30.13, (BT), 1 ♂. 'Bawi to Salalah': BM 1975. 1028–29, (W. THESIGER), 1 ♂, 1 ♀.

This population has a number of features not found in other taxa originally regarded as subspecies of *A. cantoris* Günther, 1864 and it seems best to regard it as a full species (Arnold, in prep). *A. schmidti* is usually found in aeolian sand habitats and typically occupies softer substrates than the other Dhofar *Acanthodactylus*. In north Arabia size increases abruptly, maximum snout–vent lengths sometimes being 50% greater than in southern populations. The increase occurs in the area where *A. schmidti* overlaps with another soft-sand species, *A. scutellatus*, and it is probable that it is a character displacement similar to that suggested for *A. boskianus* in the presence of *A. opheodurus*.

Genus *Mesalina* Gray

Boulenger (1920) regarded *Mesalina* as a subgenus of *Eremias*. He assigned to it two geographically isolated groups of species: one in north Africa and south-west Asia that included the type species, *Mesalina lichtensteinii* (= *M. rubropunctata*), and the other in southern Africa. Scherbak (1974) regarded the more northern forms as generically distinct from the rest of Palaearctic *Eremias* (subgenera *Eremias* s. str., *Pareremias*, *Ommateremias*, *Rhabderemias* and *Scapteira*) and raised them to full generic status. This change is supported by osteological and hemipenial features, the species concerned being the only members of *Eremias* s. lat. to have two pairs of transverse processes on the anterior autotomic caudal vertebrae and a peculiar hemipenial armature in which there are no clearly defined clavulae (see Arnold, 1973, for terminology of lacertid hemipenis structure). Defined like this, *Mesalina* includes *M. adramitana* (Boulenger, 1917), *M. brevirostris* (Blanford, 1874), *M. guttulata* (Lichtenstein, 1823), *M. olivieri* (Audouin, 1829), *M. pasteuri* (Bons, 1960), *M. rubropunctata* (Lichtenstein, 1823) and a previously undescribed form named here as *M. ayunensis*; many of these show considerable geographical variation. The south African forms originally assigned to *Mesalina* are very different and are related to other African species presently assigned to *Eremias* and *Meroles*. In fact, all these Ethiopian '*Eremias*' may also be generically distinct from *Eremias* proper.

In Arabia, five species of *Mesalina* are recorded: *M. olivieri* (Hail area and elsewhere), *M. guttulata* (mainly in the west but extending east as far as the vicinity of Riyadh and south to western South Yemen), *M. brevirostris* (north-east Arabia, coastal United Arab Emirates and west, north of the Rub' al Khali desert, to Wadi Tathlith), *M. adramitana* (south-east and south Arabia, see below) and *M. ayunensis* (Dhofar). Although areas of sympatry occur between some of these species, the distribution of *M. guttulata*, *M. brevirostris* and *M. adramitana* in the peninsula is essentially one of geographical replacement.

Mesalina adramitana (Boulenger)

Eremias adramitana Boulenger, 1917: 279. Type locality: Hadhramaut.

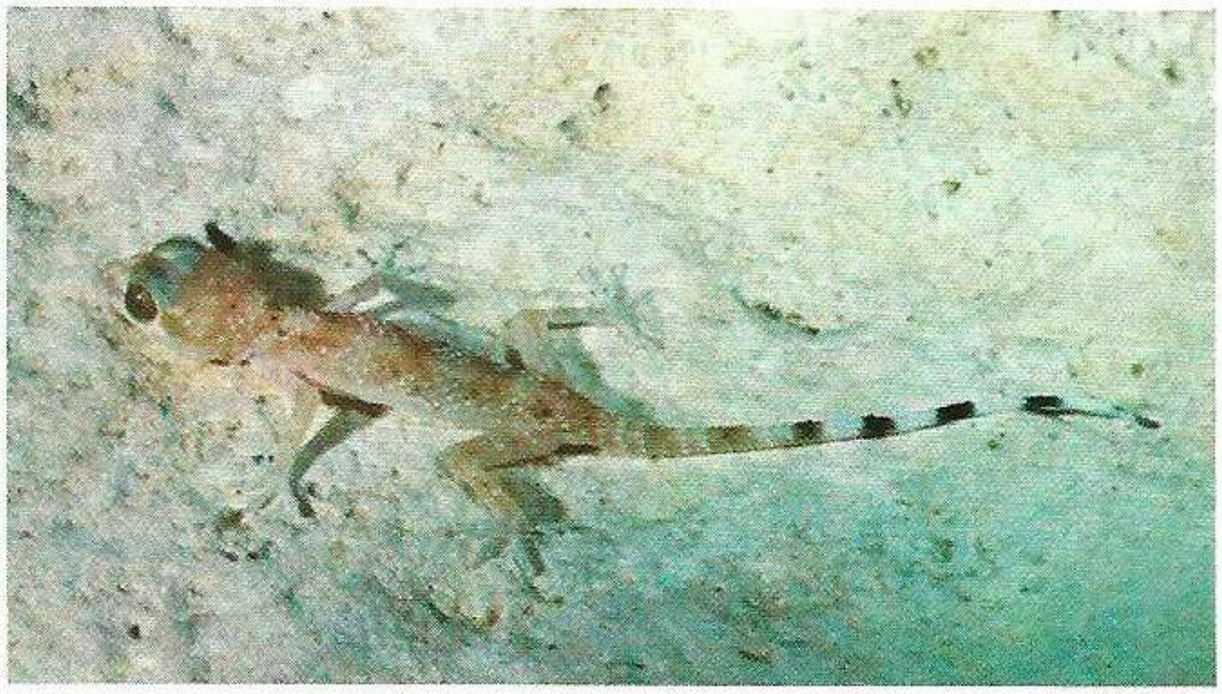

PLATE 7. *Hemidactylus yerburii*, juvenile, 30 mm from snout to vent showing striking tail colouring, at Ayun.

PLATE 8. *Pristurus carteri*, ♂, from Ayun. (Photograph W. R. Branch)

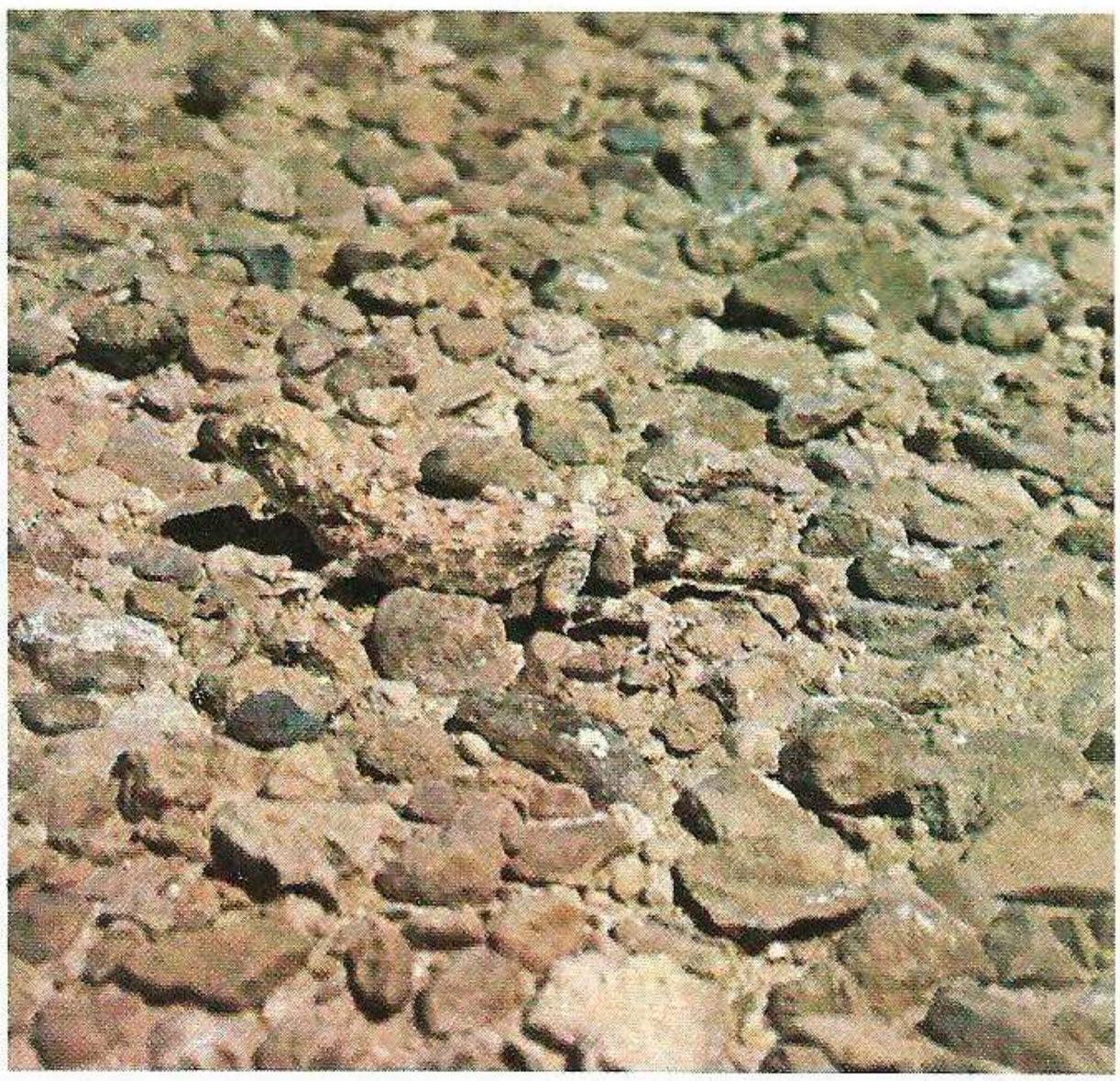

PLATE 9. *Pristurus carteri*, cool animal in early morning resting on belly, at Ayun.

PLATE 10. *Pristurus carteri*, warm animal in mid-morning standing high on legs and pale coloured to reduce heat load, at Ayun.

PLATE 11. *Pristurus carteri*, perched on shady side of piece of camel dung, at Ayun.

PLATE 12. *Pristurus minimus*, immature animal, 13 mm from snout to vent, from near Thamarit; BM 1977.1032.

TABLE 4. Geographical variation in *Mesalina adramitana*

	Hadhramaut	Dhofar Province	Masirah Island	Ras al Hadd, Muscat	United Arab Emirates, Musandam, Qatar
n	17	16	6	6	25
maximum length from snout to vent (mm)	42	40.5	41.5	46	44
number of dorsal scales across mid-body	32–40	29–37	36–41	37–40	36–45
gular scales in straight line from symphysis to collar	23–30	21–31	25–31	25–28	23–29
femoral pores under each thigh	10–15	10–14	14–17	10–14	11–13
number of lamellae under fourth toe	20–23	18–25	24–27	20–24	18–25
other features	snout especially short				tail may be tinged blue in young

DISTRIBUTION. Southern and south-eastern Arabia: Hadhramaut, Dhofar, Masirah Island, Ras al Hadd area, Muscat region, eastern United Arab Emirates, Musandam region and Qatar.

MATERIAL. 7 km E of Ayun: BM 1977.1161–66, 1 ♂, 2 ♀♀, 3 juv. 16 km S of Thamarit: BM 1977.1167, 1 ♂. Dauqa: BM 1976.1468–69, 71–72, (MDG), 2 ♂♂, 1 ♀, 1 juv. Bir ba Shu'aythan: BM 1976.1473–77, 1 ♂, 1 ♀, 3 juv.

E. adramitana exhibits some geographical variation (see Table 4). Dhofar animals are very similar to those from Hadhramaut, although the snout is not as short. To the east the next known population, on Masirah, has distinctly higher counts for femoral pores and digital lamellae than Dhofar specimens. More northern animals appear to grow somewhat larger.

While generally similar to *M. brevirostris*, *M. adramitana* can be consistently separated by its fewer longitudinal rows of ventrals (10 compared with 12) of which rows 2, 3, and 4 from the mid-line are relatively wide. The two species co-exist at at least one locality near Sharjah, United Arab Emirates. Here *M. brevirostris* grows larger than elsewhere in Arabia (up to 59 mm from snout to vent compared with about 50 mm or less) and occurs mainly in and around low, dense halophytes close to the shore but is largely replaced by *M. adramitana* on hard, dry, more open substrates nearby.

In the eastern United Arab Emirates, *M. adramitana* is usually found on a variety of quite hard surfaces with sparse vegetation, including compacted sand, and gravel plains but, in the absence of *Acanthodactylus*, also sometimes occurs on softer sand near the sea. In Dhofar it was found on flat hard sandy areas with shrubs and small stones which it used as refuges. In the UAE the body temperatures of ten normally active adults were 37 (1), 37.5 (2), 38 (2), 39 (4), 40.2°C (1), but both here and in Dhofar, adults and juveniles were often seen on surfaces with temperatures of around 50°C; in such situations they often climbed into small shrubs where temperatures were lower away from the ground.

Mesalina ayunensis sp. nov. (*Plates* 19 *and F*)

At Ayun, another species of *Mesalina* occurs with *M. adramitana*, differing from it in several morphological features and in habitat. As it is also distinct from the other members of the genus it is described here as a new species. Its closest relative is *M. adramitana*.

ORIGIN OF NAME. From the type locality.

DISTRIBUTION. Known only from Ayun, Dhofar.

MATERIAL. *Holotype*. Ayun: BM 1977.1169, (E. N. ARNOLD), 8.10.1977, ♂. *Paratype*. 7 km E of Ayun: BM 1977.1168, (E. N. ARNOLD), 12.10.1977, ♀.

PLATE F. *Mesalina ayunensis* sp. nov., holotype, ♂, 38.5 mm from snout to vent, from Ayun; BM 1977.1169.

DIAGNOSIS. (As only two specimens are known, ranges for scale counts are minima). Up to at least 44 mm from snout to vent, quite slender, snout not very short, internasals in contact behind rostral, occipital scale very small or absent; lower eyelid with a number of enlarged, translucent, unpigmented scales in centre. Dorsal scales 44–47, gulars 32–35 without a gular 'fold', ventrals in 10 longitudinal series, a clearly defined row of enlarged scales beneath lower foreleg; femoral pores 16–18 on each side; scales on upper surface of tibia smooth and small, not obviously larger than dorsal scales between hind legs and meeting large scales on lower surface of tibia abruptly; 27–28 strongly bicarinate lamellae beneath fourth hind toe. Dorsum fairly uniform without dark flanks, tail bright blue in life; hemipenis not small (over 10% of snout-vent distance when fully everted).

Sympatric *M. adramitana* are smaller (up to 41 mm) and less slender, have fewer dorsals (29–37), a gular 'fold', no clear row of enlarged scales beneath lower foreleg, 10–14 femoral pores on each side, some of the scales on upper tibia distinctly larger than dorsals between hind legs and enlarged where they meet ventrals on outer surface of limb, 21–26 less strongly keeled lamellae beneath fourth toe, usually dark flanks, tail not blue and a smaller hemipenis (less than 10% of snout-vent length when erect). More eastern populations of *M. adramitana* may overlap with *M. ayunensis* in some features such as larger size (up to 46 mm, dorsals up to 45, femoral pores to 17, dorsal scales on tibia not always enlarged, lamellae under fourth toe up to 27, tail sometimes bluish in juveniles and hemipenis not small.

M. ayunensis differs most obviously from *M. brevirostris* in its lower ventral count (10 not 12 longitudinal rows) longer snout and blue tail. Other members of genus also lack a blue tail, usually have a well developed occipital scale and also differ as follows: *M. olivieri*, *M. pasteuri* – keeled tibials, *M. guttulata* – keeled tibials, black-edged scales in lower eyelid, *M. rubropunctata* – 12 rows of ventrals, rostral usually in contact with frontonasal.

DESCRIPTION OF HOLOTYPE. A mature male preserved initially in formalin and later transferred to alcohol; tail broken but distal portion present; hemipenes everted.

A relatively small, rather slender *Mesalina* with quite long limbs, a strongly depressed head and a pointed, not very short snout. Head length (from snout tip to squamosal bone located through unbroken skin) about 27% of distance from snout to vent, slightly over twice head width at jugals and rather less than twice width in quadrate region; depth about $\frac{2}{3}$ of latter measurement; pileus about $1\frac{1}{2}$ times as broad as long. Neck expanded laterally, almost as broad as head. Tips of fingers extend slightly beyond snout-tip, adpressed

hind limb reaches posterior border of ear; foot about $1\frac{1}{3}$ head length. Digits very strongly compressed, at least twice as deep as wide. Tail slender, about 2.6 times snout–vent distance, broad and rather depressed at base, slightly compressed distally.

Internasal scales in contact behind nostril, their common suture about a sixth of the frontonasal length; frontonasal very slightly wider than long, more or less hexagonal; prefrontals $1\frac{1}{6}$ length of frontonasal with a common suture about $\frac{2}{7}$ of their length. Frontal slightly shorter than the distance from its anterior edge to the snout tip, about twice as long as its maximum width, its anterior border formed by two obliquely intersecting curves, posterior width about $\frac{3}{10}$ of length. Frontoparietals paired and in contact, each rather more than half the length of the frontal, their common suture about $\frac{2}{3}$ their length; parietals slightly shorter than frontal, the posterior width of each about $\frac{3}{4}$ of its length. Interparietal large, more or less lozenge shaped with a clear parietal foramen situated anteriorly, about $\frac{3}{5}$ the length of the frontal and about as wide as this scale. Occipital scale entirely absent. Four supraoculars present on each side, the first small, in contact with frontal and divided into four, the second and third large and the fourth smaller than the first. Supraciliaries 5/5, first longest, separated from second and third supraoculars by a complete series of granules of which there are 15 on each side.

Nostril widely separated from the rostral and upper labial scales by a large internasal anteriorly and dorsally and by a large subnasal beneath; a small postnasal wedged between these meets the posterior margin of the nostril. Two loreals present, both longer than high, the more anterior slightly over half length of the posterior which is in contact with the frontonasal and prefrontal. 4/4 upper labials anterior to subocular scale which borders the mouth broadly, its lower margin being about $\frac{5}{8}$ the length of the upper one, 4/5 upper labials posterior to it. Lower eyelid with about 11/11 enlarged scales forming a translucent central disc, the hind part of its upper margin clearly reflexed. A single postocular in contact with the fourth supraocular, the last supraciliary and the parietal. 8/8 supratemporal scales along the edge of the parietal, the anterior ones somewhat larger than adjoining temporals and all of them largely off the parietal table of the skull; remaining temporals granular, the lower ones somewhat enlarged, 10 in a line between the supratemporals and rictus. No masseteric shield; tympanic scale large, elongate and unkeeled, bordered antero-dorsally by four quite large scales. Ear hole large, its height about equal to width of eye opening; anterior edge of ear formed by tympanic above and by 4/4 scales below which form a lobed edge.

Lower labials 9/8. Five pairs of chin-shields, the first three in contact, the fourth largest. 32 gular scales in a straight line between collar and symphysis of chin shields, the anterior ones slightly imbricate and the posterior markedly so and broad; no gular 'fold' or transverse band of smaller scales. Collar curved, rather serrated, made up of ten scales, the four median ones not reflectable and without granules beneath.

Dorsal scales granular, non-imbricate, unkeeled, ovoid in outline, becoming larger, slightly imbricate and more elongate on lower flanks. 44 dorsal scales in a transverse row at mid-body. Two dorsal rows correspond to each ventral one. Ventral plates in ten longitudinal and 31 transverse rows, those in six median longitudinal ones wider than long; outermost row less than half width of penultimate one and restricted to about 10 scales in the mid-body region. Preanal plate large and broad, surrounded by a semicircle of six large scales and an outer irregular concentric series of smaller ones.

Upper forelimb with four longitudinal series of large, imbricate, round-edged plates above and granular scales below. Lower limb like upper above but scales smaller, especially proximally where they are round and non-imbricate; distally there is a short series of laterally expanded scales on wrist; anterior surface of lower limb covered by a series of large plates, ventral surface with small scales interrupted by an axial series of about 14 large plates from elbow to wrist. Digits with a single row of scales above and below, the latter each with two strong keels that are directed obliquely forwards and downwards and end in bluntly spinous processes.

Thigh with small granular scales above and behind which are rather smaller than dorsal body scales; a row of very large plates anteriorly, bordered above by large rather pointed imbricate scales that grade into dorsals and below by similar scales that decrease in size towards femoral pores. Femoral pores 17/16, the two series separated by two scales on mid-line and almost reaching the knee. Tibia with a series of about nine very large plates beneath and one of rather smaller plates behind. Dorsum of tibia covered by small, smooth, rounded, slightly imbricate scales that are

scarcely larger than dorsals in sacral region. Digits on foot like those on hand; fourth toe with 27/28 subdigital lamellae.

Caudal scale whorls alternately slightly longer and shorter, the dorsal and lateral scales with keels that form roughly straight longitudinal lines; ventrals smooth, the two median rows expanded. 21 scales in fifth caudal whorl behind vent granules.

Colour in spirit. Light blue-grey but limbs paler distally and head buffer. An irregular dorsolateral series of very weak, small, darker-edged ocelli on each side from mid-back to tail base and a few light spots on tibia; underside white and tongue pale. In life generally buff above and blue on back of thighs and on tail becoming more intense distally but paler beneath.

Size. Snout to vent: 43.5 mm; head length: 12.0 mm; tail: 110 mm.

DESCRIPTION OF PARATYPE. Generally similar to holotype but parietal foramen in centre of interparietal scale, a very small occipital scale present which is separated from interparietal, first supraocular divided into 3/2 fragments, 3/3 supraciliary scales, 13/13 supraciliary granules, 4/3 upper labials posterior to subocular, 8/8 lower labials, 35 gulars, collar with 11 scales and markedly serrated, 47 dorsal scales in a transverse row at mid-body, 30 transverse rows of ventrals, scales under thigh more numerous, 18/18 femoral pores, 27/27 subdigital lamellae under fourth toe; a weak pattern of small light spots on dorsum and hind limbs.

Size. Snout to vent 38.5 mm; head length 11 mm; tail 88 mm.

SKELETAL FEATURES (based on radiographs). Skeleton generally like other *Mesalina*; about 7 teeth in premaxilla, 16 in maxilla and 23 in mandible; 24 presacral vertebrae, the last without ribs; three sternal and one complete xiphisternal rib pairs; 8 non-autotomic caudal vertebrae in male, 7 in female; two proximal autotomic vertebrae bearing two pairs of transverse processes.

HEMIPENIS. Over 10% of snout–vent distance when everted, bifurcate for about a quarter of total length, no obvious ornamentation; armature present and deeply bifurcate but not investigated in detail.

ECOLOGY. In addition to the holotype and paratype, another three individuals were observed. All were on often sloping, coarse gravel surfaces with extremely sparse vegetation, although in two instances the lizards were in tiny wadis where plants were somewhat more abundant than in the surrounding country. *M. ayunensis* was never seen on the flat sandy areas favoured by *M. adramitana* and was much rarer and more shy than this species. This may reflect the lower productivity of the gravel areas, where the only other diurnal lizard encountered was *Agama sinaita*.

Mesalina sp.

MATERIAL. Dauqa; BM 1976.1470, 1 ♂.

A single poorly preserved specimen from Dauqa differs from the *M. adramitana*, amongst which it was collected, in its finer dorsal scaling (53 instead of 35–37 across mid-body), fewer gulars (34 instead of 27–31), ventrals not clearly separated from dorsals, more femoral pores (16/15 compared with 12–14), upper tibials not clearly larger than dorsals between hind legs, and striped dorsal pattern. In some of these features, it resembles *M. ayunensis* but does not agree in its ventrals, femoral pore count, lack of large scales beneath lower foreleg and pattern. Until more material is available, this lizard must be regarded as *incertae sedis*.

Family SCINCIDAE: skinks

Chalcides ocellatus (Forskål)

Lacerta ocellata Forskål 1775: 13. Type locality: Egypt.

DISTRIBUTION. North Africa, parts of Mediterranean Europe, south-west Asia to Pakistan. In Arabia, mainly distributed around coast.

MATERIAL. Salalah and environs: BM 1931.7.16.53, (BT), BM 1971.1656 (A. J. RIVERS), BM 1975.1384 (T. D. ROGERS), BM 1976.1478 (MDG), BM 1977.1170–76, ♂♂, ♀♀.

All specimens have mid-body scale counts of 28 which is within the usual range for *C. ocellatus* in the east of its distribution. Dorsal colouring is similar to that of other Arabian examples, the pattern consisting of small light spots flanked by dark pigment which may become confluent to produce irregular bars. Occasionally there are dark streaks on the nape and some animals have an incomplete vertebral stripe. The hemipenis is very small in this species and determination of sex is best carried out by abdominal dissection.

C. ocellatus is secretive but abundant in plantations

and cultivated areas where the ground is often damp, especially near the sea. It was frequently encountered when piles of leaves were turned over and among refuse particularly on soft sandy earth. This skink occupies similar situations elsewhere in east Arabia.

Mabuya brevicollis (Wiegmann)

Euprepis brevicollis Wiegmann, 1837: 133. Type locality: 'Abyssinien'.
Euprepis pyrrhocephalus Wiegmann, 1837: 133. Type locality: Aschik Island, Red Sea.
Mabuya pulchra Matschie, 1893: 29. Type locality: Lahadsch (= Lahej)

DISTRIBUTION. North-east Africa from Eritrea to Tanzania; western and southern periphery of Arabia from Taif to Dhofar and also apparently northern Saudi Arabia near Bureidah.

MATERIAL. Wadi Sayq: BM 1977.1179, 1 ♀. Wadi Sarfait: BM 1977.1177–78, 1 ♀, 1 juv. Khadrafi: BM 1977.1181, 1 ♂. Rayzut: BM 1978.777, (MDG), 1 ♀. Salalah: BM 1975.1385–86, (S. MOULT, T. D. ROGERS), BM 1976.1479 (MDG), BM 1977.1180, 2 ♂♂, 2 ♀♀.

This species exhibits considerable variation in colour. At some African localities, young are very dark with small light spots while at others they are lighter with bold, dark vertical bands on the flanks; in both instances the pattern later breaks up into dark spots and this stage is very similar to neonates from Arabia. Adults also vary geographically, although less conspicuously, and even in Arabia there are differences from place to place as well as individual variation. In Dhofar a broad, light, dorsolateral band is present and females have a series of dark blotches on the dorsum; males are more uniform but have blackish heads with small light spots and often a scattering of light spots on the body. Animals from the Khadrafi area were often very dark.

In Dhofar *M. brevicollis* occurs from sea-level to at least 1,000 m but does not extend far inland from the crests of Jabal Qamr and Jabal Qara. It is often associated with vegetation, being found in irrigated plantations among leaf litter and dense herbage near Salalah. At Wadi Sayq, Khadrafi and Wadi Sarfait it was common in grassy vegetation and on rocky slopes with grass and bushes where it basked on rocks, occasionally over a metre from the ground, and took refuge in large crevices and beneath boulders. Animals seen near the sea on Salalah plain were in more open situations on rock outcrops. This large skink is diurnal, largely ground-dwelling and appears to forage actively. It is quite abundant but shy and once disturbed does not stop until it reaches cover. No young were seen in September and October. In Arabia *M. brevicollis* is live-bearing. Body temperatures of naturally active animals were 36.5, 36.5, 37 and 37°C.

Mabuya tessellata Anderson (*Plate 20*)

Mabuya tessellata Anderson, 1895: 649. Type locality: Aden.

DISTRIBUTION. South Arabia: Yemen to Dhofar; northern Oman.

MATERIAL. Wadi Sayq: BM 1977.1182–83, 1 ♀, 1 ♂. Ayun: BM 1977.1184–85, 1 ♂, 1 juv. Wadi Ghayz: BM 1980.218, (J. N. BARNES), 1 ♂. Wadi Baqlat, 12 km E of Mirbat (17°01′N 54°48′E): BM 1977.1187–88, 1 ♀, 1 ♂. Wadi Raykhut: BM 1977.1186, 1 ♂.

Loveridge (1957) placed *M. tessellata* in the synonomy of *M. brevicollis*, but there is no doubt that it is a distinct species. These are the first specimens recorded from Dhofar. They have mid-body scale counts of 30–33, a range intermediate between those known for south-west Arabia (32–34, n = 4) and northern Oman (29–31, n = 5). Like south-western animals, those from Dhofar have a laterally expanded row of scales on the dorsal mid-line of the tail restricted to its tip. Colouring is rather variable, animals from moister habitats (Wadi Ghayz, Wadi Sayq and Baqlat) being less pallid than the others; Wadi Ghayz and Wadi Sayq animals also have weak, light dorsolateral stripes anteriorly. The tail is often tinged yellow in life.

As in northern Oman, this small, shy skink climbs on rock faces, rock slides, boulders and sloping pavements. Typically these are in the vicinity of water and vegetation is often present. *M. tessellata* climbs higher and better than *M. brevicollis* and, unlike this species, was not seen foraging on the ground among vegetation, although it does so in northern Oman. Body temperatures of two naturally active animals were about 35 and 36°C.

Scincus mitranus Anderson

Scincus mitranus Anderson, 1871: 115. Type locality: Arabia.

DISTRIBUTION. Arabia, excluding west and north-west.

MATERIAL. Ramlat Shu'ait, 1,000 ft. (310 m): BM 1931.7.16.54, (BT), 1 ♀. Kharaiyim Fasad, 850 ft. (260 m): BM 1931.7.16.56, (BT), 1 juv. Thamarit: BM 1980.214–17, (J. N. BARNES), 1 ad., 1 ♀, 2 juv.

Systematics and variation of *Scincus mitranus* are discussed by Arnold & Leviton (1977). The specimens from Thamarit are similar to animals from Masirah and Muscat in their narrow snouts, low mid-body scale counts (24, 25, 26, 26) and in having the first loreal scale contacting the frontonasal. The other Dhofar individuals resemble more northern animals. *Scincus mitranus* is typically associated with aeolian sand.

Suborder SERPENTES

Family LEPTOTYPHLOPIDAE: thread snakes

Leptotyphlops macrorhynchus (Jan)

Stenostoma (*Ramphostoma*) *macrorhynchum* Jan, 1861: 190. Type locality: Sennaar, Sudan.

DISTRIBUTION. West Africa to north-west India.

MATERIAL. Thamarit: BM 1980.219, (J. N. BARNES).

This minute and widely distributed snake is sometimes inadvertently transported in soil, so its occurrence at Thamarit may not be natural.

Family BOIDAE: boid snakes

Eryx jayakari Boulenger

Eryx jayakari Boulenger, 1888: 508. Type locality: Muscat.

DISTRIBUTION. Arabia, Iraq.

MATERIAL. Shisur (18°15′N 53°38′E): BM 1978.343, (MDG), 1 juv; D 44, V 167, C 23. Haima camp (19°55′N 56°20′E): BM 1976.1482, (MDG); D 42, V 167, C 17.

The Shisur example came from an area of stony desert partly overlaid by wind-blown sand and was taken on a patch of this. In the United Arab Emirates, this snake is also associated with aeolian sand in which it burrows well and is typically only encountered on the surface at night. Food includes geckoes, such as *Stenodactylus doriae*.

Family COLUBRIDAE: typical snakes

Atractaspis microlepidota andersonii Boulenger

Atractaspis andersonii Boulenger, 1905: 180. Type locality: El Kubar, near Aden.

DISTRIBUTION. South Arabia: from south-west Saudi Arabia to western South Yemen; Dhofar.

MATERIAL. Aizat, 2,000 ft. (620 m), Jabal Qara: BM 1931.7.16.82, (BT), 1 ♀.

The Dhofar specimen is generally like those from Aden although its ventral count is rather higher (252 compared with 223–243 for four females). The sexual difference in dorsal scale count is not as clear-cut as Parker (1931) suggested: of four males, three have 23 dorsals across the mid-body and one has 24, while of five females one has 23, three have 24 and one 25.

A. m. andersonii is a race of a species widespread in the savannah areas to the south of the Sahara and in north-east Africa. It is possible that it intergrades with the rather similar *A. engaddensis* Haas, 1950 described from Palestine. Gasperetti (1977) reports an *Atractaspis* similar to this form from near Khamis Mushayt (18°44½′N 43°15′E) about 200 km from Wadi Jizan, Asir, where typical *A. m. andersonii* has been collected.

Coluber rhodorhachis (Jan) (*see Branch, 1980, this volume, Plate 2, p. 337*)

Zamenis rhodorhachis Jan, 1865: 356. Type locality: Persia.

DISTRIBUTION. North-east Africa to northern India; in Arabia widespread in the west and south.

MATERIAL. Wadi Sayq: BM 1977.1190, (MDG). Wadi Sarfait: BM 1976.1484. Salalah: BM 1975.2097, BM 1977.1189. Jabal Qara, 500–2,000 ft. (150–620 m): BM 1931.7.16.59–67, (BT). Wadi Darbat: BM 1977.1191.

Examples were also seen at Wadi Nahiz and Wadi Raykhut. Both spotted and plain individuals are present in Dhofar, the former apparently predominating. As in northern Oman, this snake is frequently encountered by day in moist, rocky wadis, often in the vicinity of open water, but it may also occur in more open areas with vegetation, in gardens, around buildings and even in pools by the sea. It moves extremely fast when disturbed and climbs well even on almost vertical rock surfaces, if they are rough enough to give purchase.

TABLE 5. *Coluber thomasi*, details of the three known specimens

	Jabal Qara (type) ♀	Khawr Sawli ♂	Eastern South Yemen ♀
dorsal scales in transverse			
row at: neck	15	17	17
mid-body	15	15	15
in front of vent	13	13	13
ventral scales	156	156	160
subcaudal scales	80	82	79
upper labial scales	8	8	8
lower labial scales	8	8	8
postocular scales	3/2	2/2	2/2
maxillary teeth	11 + 2	—	12 + 2
dark vertebral blotches: body	33	37	32
tail	23	19	23
total	56	56	55
length (mm): head and body	156	278	204
tail	57	111	76
total	213	389	280

Coluber thomasi Parker (*Plate 21*)

Coluber thomasi Parker, 1931: 516. Type locality: Ain, Jabal Qara.

DISTRIBUTION. Known only from Dhofar and eastern South Yemen.

MATERIAL. Ain, Jabal Qara 1,500 ft. (460 m): BM 1931.7.16.68/1946.1.14.73, (BT), ♀, holotype. East Aden Protectorate (= eastern South Yemen): BM 1962.935, 1 ♀. Khawr Sawli: BM 1977.1193, 1 ♂.

The individual from Khawr Sawli is only the second specimen to be taken since *Coluber thomasi* was described; it is also the only male and probably the only adult as well. In nearly all important features it agrees with the type, most differences probably being due to growth effects. However, the snout is more acutely pointed, temporal scales are 2+2/2+2 (not 2+3/2+2), the fourth upper labial is excluded from the edge of the eye by contact between the fifth upper labial and the lower preocular (subocular of Parker) and there is no dark bar across the snout. Other features of the three known specimens of *C. thomasi* are compared in Table 5. Plate 21 shows general appearance in life. The flanks are tinged pink on the anterior and middle of the body, increasing in intensity towards the ventral surface which is whitish; the eyes are blackish with a gold ring at the edge of the pupil. The hemipenis is of typical *Coluber* form; the proximal three-fifths of the organ is covered by numerous small, backwardly directed spines but the rest of the surface is fairly smooth.

As Parker suggested, the relationships of *C. thomasi* seem to lie with *C. variabilis* (Boulenger, 1905) of the Aden region, which it resembles in size, habitus and many aspects of scaling. *C. variabilis* sometimes also has a faint vertebral stripe like *C. thomasi* but the latter has only 15 scale rows at mid-body and its dorsal pattern is different. One of the morphs of *C. variabilis* ('A' of Boulenger) is superficially similar in having transverse bars on the head and a series of blotches on the dorsum but these do not run onto the flanks as they do in *C. thomasi* being replaced instead by a row of staggered blotches; the ground colour is also less bright. The hemipenis of *C. variabilis* (based on four specimens: BM 1903.1.28.10, BM 1903.1.28.12, BM 1903.6.26.39, BM 1907.3.7.9) differs from that of the one *C. thomasi* available in being caliculate distally.

The *C. thomasi* from Khawr Sawli was caught at dusk emerging from beneath a stone on a shallow slope of hard, sandy ground with pebbles and low (30 cm high), well separated shrubs. *Pristurus carteri, P. rupestris* and *Hemidactylus homoeolepis* were all active at the time and may have been potential prey.

VERNACULAR. *Shalthum* (Thomas, 1932)

Lytorhynchus diadema (Duméril, Bibron & Duméril)

Heterodon diadema Duméril, Bibron & Duméril, 1854: 779. Type locality: Algeria.

Lytorhynchus gaddi Nikolsky, 1907: 294. Type locality: Dizful (= Dezful), Khuzistan, Iran.

DISTRIBUTION. North Africa; Arabia and neighbouring areas to the north; south-west Iran.

MATERIAL. 7 km E of Ayun: BM 1977.1194, 1 ♂; D 19, V 159, C 40.

Leviton & Anderson (1970) divided the *Lytorhynchus* frequently placed in *L. diadema* into two species which they acknowledged to be very closely related; these are *L. diadema* itself in north Africa and Palestine and *L. gaddi* in south-west Asia. Separation is based on ventral scale number, *L. diadema* being said to have 152–177 and *L. gaddi* 173–195. However, a specimen from Libya (BM 1955.1.1.48) has a count of 180 and specimens from Arabia are now known with ventral numbers within the expected range of *L. diadema*. Leviton (1977) mentions three from south-west Saudi Arabia, BM 1977.1194 from Abha in this area has 167 ventrals and the Dhofar specimen 159. Given the extremely close resemblance between *L. diadema* and *L. gaddi* in other features, these counts suggest that the two supposed forms are conspecific.

In Arabia *L. diadema* appears to occur in a wide range of dry habitats from sea level to as much as 2,300 m in south-west Saudi Arabia. The Ayun snake was found dead on a hard sandy plain, although there were limited amounts of softer sand near-by, and the Abha specimen came from a rocky area with pockets of sand. In the United Arab Emirates *Lytorhynchus* has also been taken from such comparatively hard substrates but it also occurs on acolian sand dunes with sparse vegetation. In this area, *Lytorhynchus* comes to the surface at night and, even on soft sand, does not side-wind but progresses by normal serpentine locomotion.

Malpolon moilensis (Reuss) (*Plate 22*)

Coluber moilensis Reuss 1834: 142. Type locality: Moilah.

DISTRIBUTION. North Africa, Arabia and neighbouring areas to the north.

MATERIAL. Bin Juay, 1,470 ft. (450 m): BM 1930.6.30.17, (BT), 1 ♂; D 17, V 152, C 54. Wadi Hauf (= Wadi Haluf) 1,150 ft. (350 m): BM 1931.7.16.70, 1 ♀; D 17, V 163, C 56. Jiddat al Harasis, (19°45′N 56°45′E): BM 1978.348, (MDG), 1 ♂; D 17, V 154, C 60. 20°10′N 57°00′E: BM 1978.811, (MDG), 1 ♂; D 17, V 156, C 62.

Animals from south-east Arabia (Sultanate of Oman and United Arab Emirates) have rather lower ventral counts than those from elsewhere in the peninsula: south-east Arabia usually 150–164 (one animal with 172, n = 12); other areas 160–177 (n = 22).

M. moilensis appears to be diurnal in a wide range of open dry habitats, often with relatively hard substrates. When disturbed, it may flatten its neck, expanding it laterally.

Psammophis schokari (Forskål)

Coluber schokari Forskål 1775: 14. Type locality: Yemen.

DISTRIBUTION. North Africa and Middle East to north India. Widespread in Arabia.

MATERIAL. Al Qatan, Jabal Qara, 2,500 ft. (770 m): BM 1930.6.30.18, (BT), 1 ♂; D 17, V 174, C 135. Fuzul, Jabal Qara: BM 1931.7.16.71, (BT); D 18, V 174, C 123+. Jabal Qara: BM 1931.7.16.72, (BT), 1 ♀; D 17, V 168, C—. 17°20′N 54°04′E: BM 1978.1100, 1 ♀. Thamarit: BM 1980.223, (J. N. BARNES), 1 juv.

Snakes apparently of this species were also seen amongst dense grass and bushes at Wadi Sayq; like the preserved material from Jabal Qara they were longitudinally striped whereas in many parts of Arabia the majority of *P. schokari* are more or less plain as is the example from Thamarit. Observations in the United Arab Emirates suggest that this species occurs in a variety of habitats which usually have trees, bushes or at least very low shrubs; food appears to include a substantial proportion of birds.

Spalerosophis diadema (Schlegel)

Coluber diadema Schlegel 1837: 148. Type locality: near Bombay.

DISTRIBUTION. North Africa (but excluding most of the Sahara) through the Middle East to northern India; in Arabia known from the north, the western and southern periphery and northern Oman.

PLATE 13. *Agama sinaita*, adult ♂, at Ayun. (Photograph A. Dunsire)

PLATE 14. *Agama sinaita*, immature animal, at Ayun. (Photograph A. Dunsire)

PLATE 15. *Uromastyx thomasi*, subadult, about 160 mm from snout to vent, from Al Ajaiz. (Photograph M. D. Gallagher)

PLATE 16. *Uromastyx thomasi*, juvenile, 78 mm from snout to vent, from Masirah Island; BM 1973.2907.

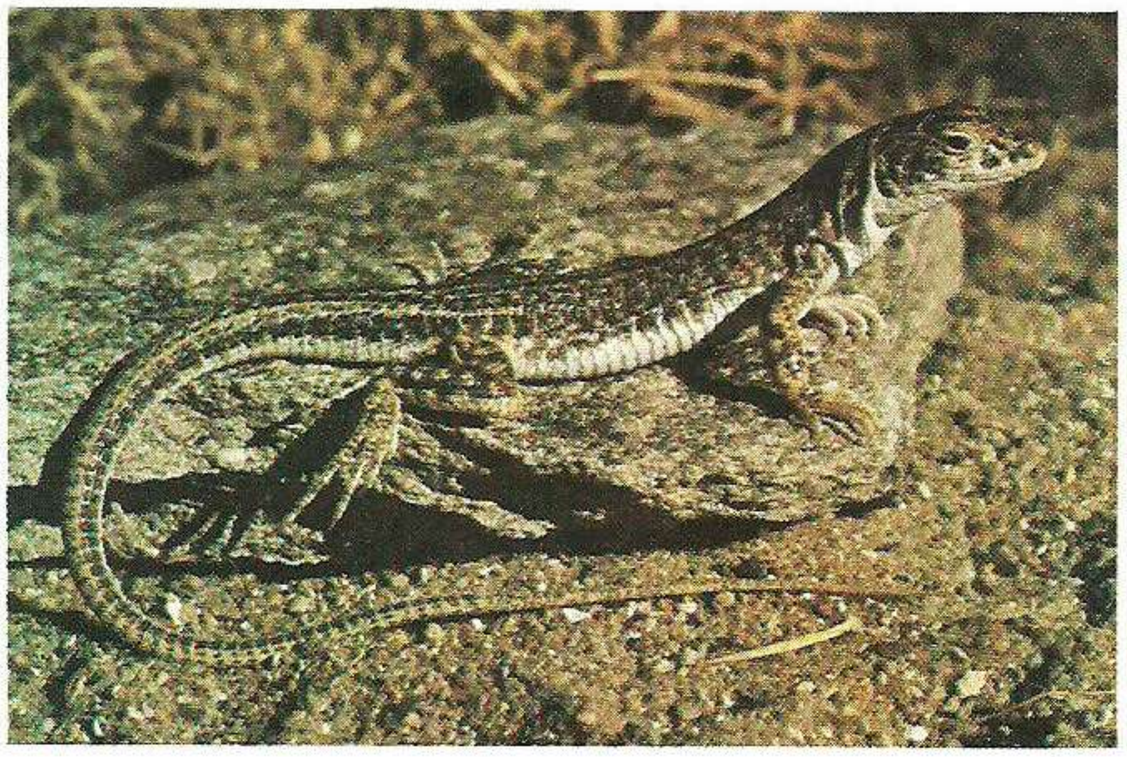

PLATE 17. *Acanthodactylus opheodurus* sp. nov., ♂, 54 mm from snout to vent, from near Taif, Saudi Arabia, collected by J. Gasperetti; BM 1978.2267. (Photograph W. R. Branch)

PLATE 18. *Acanthodactylus felicis* sp. nov., at Ayun. (Photograph A. Dunsire)

MATERIAL. Salalah: BM 1931.7.16.69, (BT); D 29, V 220, C—.

Like other Arabian material examined (n = 19), this individual is assignable to *S. d. cliffordi* (Schlegel, 1837) which is widespread from north Africa to south-west Iran. A note accompanying the specimen states that *Spalerosophis* occurs around houses in Salalah and on the surrounding plain.

Telescopus dhara (Forskål)

Coluber dhara Forskål, 1775: 14. Type locality: Yemen.

DISTRIBUTION. Mauretania to Nigeria; north-east Africa and Arabia, where it occurs mainly in the vicinity of the western and eastern coasts and in northern Oman.

MATERIAL. Salalah: BM 1971.1658 (A. G. RIVERS), 1 ♀; BM 1978.2262, (MDG), 1 juv. Rakhyut, Jabal Qamr: BM 1977.1195, 1 ♂. Taqah: BM 1977.1197, 1 ♂. Wadi Darbat, Jabal Samhan: unregistered. Another individual which had entered an aviary in Salalah was photographed by A. Dunsire.

Surprisingly, this snake has not previously been reported from Dhofar. The five animals listed all agree with typical *T. dhara* from Arabia which have single preanal scales and usually 21 (occasionally 19) rows of dorsal scales at mid-body. In the western and southern parts of its Arabian range as far east as Masirah, this snake has 229–251 ventral scales (n = 28) but in the mountains of northern Oman (Khasab, Rostaq, Wadi Bani Kharus) counts are higher, ranging from 257–280 (n = 6).

In northern Oman, *Telescopus* occurs in rocky places; the Rakhyut animal was found dead on a stony plain, and that from Wadi Darbat was under a rock among grass. The five Oman specimens which have been collected when naturally active were all taken after dark. BM 1971.1658 contained a small chameleon and the Salalah individual found in an aviary had eaten a small passerine; Corkhill & Cochrane (1965) also mention that this species eats birds.

Family ELAPIDAE: cobras

Naja haje (Linnaeus)

Coluber haje Linnaeus 1758: 225. Type locality: Lower Egypt.

DISTRIBUTION. *N. h. haje* in north and north-east Africa (excluding the Sahara) with two other subspecies to the south. In Arabia confined to western and southern peripheries as far east as Dhofar.

TABLE 6. Geographical variation in *Naje haje*

	dorsal scales across neck 19	20	21	22	23	dorsal scales across mid-body 19	20	21	22	23	number of ventral scales	number of subcaudal scales
Naje haje haje in Africa (Broadley, 1968)						3		49			195–220	54–65
Arabia												
Medina (Anderson, 1898)					1			1			213	54
South-west Saudi Arabia	3					1		3			210–218 (n = 30)	68–69 (n = 3)
North Yemen (BM; Scortecci, 1932; Cherchi & Spano', 1966)	5	4	2			2	5	4			204–226 (n = 12)	62–77 (n = 9)
Western South Yemen	2	1	3			1	5				202–218 (n = 6)	70–79 (n = 3)
Dhofar (and one example from Mukallah)	8					6	2				215–221 (n = 8)	73–80 (n = 6)
Somalia	1		6		1	1		9			198–211	58–64

MATERIAL. Khiyunt, Jabal Qara, 1,450 ft. (440 m): BM 1931.7.16.73, (BT), 1 ♀. Al Quatan, near Bu Matahan, 2,000 ft. (620 m): BM 1931.7.16.74, (BT), 1 ♂. Ahayrkot, Jabal Qara, 450 ft. (140 m): BM 1931.7.16.75, (BT), 1 ♂. Jabal Qara, 500 ft. (155 m): BM 1931.7.16.76, (BT). Wadi Darbat: BM 1976.1487, (P. SICHEL/MDG), 1 ♀. Khadrafi: BM 1977.1198, 1 juv. Another individual from Jabal Qara is briefly described by Haas (1957).

Variation in the available Arabian material is summarised in Table 6. An animal from Medina listed by Anderson (1898) agrees with the typical race but the remainder which come from further south (the northernmost being one from Sayl al Kabir north of Taif – Gasperetti, pers. comm.) show some differences and have been treated as a separate subspecies, *N. h. arabica* Scortecci, 1932 (type locality Sana'a, Yemen). The most obvious characteristic is a high number of subcaudal scales: usually 66–80 compared with 54–65 in *N. h. haje*. But there is variation in this and other features within Arabia; thus subcaudal count tends to be higher in the extreme south and east, dorsal scales across the mid-body are most frequently 20 or 21 in the west and 19 in the east and scales around the neck show a similar trend. Dhofar animals are therefore the most differentiated from *N. h. haje*. Until more material is collected from western Saudi Arabia, it is not clear if *N. h. arabica* can be clearly separated from *N. h. haje* or whether variation is essentially clinal.

This cobra appears to be confined to relatively mesic places, all the Dhofar localities being well vegetated and not far from water. The Wadi Darbat specimen was 2.5 m up a tree and a juvenile from Khadrafi was in a precipitous rocky wadi. Local people mentioned very large snakes that lived in grassy vegetation near water at Ayun, Wadi Sayq and Wadi Raykhut; these could well have been cobras, for elsewhere in Arabia *N. haje* can reach nearly 1,800 mm (Parker, 1938 – Najran). Gasperetti (1974), also records this snake in similar habitats and Corkhill & Cochrane (1965) report several from near water. Parker (1931) suggests that animals with only 19 scale rows on the neck cannot dilate it, but this certainly occurred in the Wadi Darbat and Khadrafi snakes and Gasperetti records dilation in Saudi specimens.

Family VIPERIDAE: vipers

Bitis arietans Boulenger

Bitis arietans Boulenger, 1896: 493. Type locality: —.

DISTRIBUTION. Savannah areas of Africa; western and southern peripheries of Arabia as far north as Taif (Gasperetti, pers. comm.) and as far east as Dhofar.

MATERIAL. In, Dhofar littoral 600 ft. (185 m): BM 1931.7.16.79, (BT), 1 ♀. Sharin, Jabal Qara 1,250 ft. (380 m): BM 1931.7.16.80, (BT), 1 ♂. Fuzul, Jabal Qara 1,350 ft. (410 m): BM 1931.7.16.81, (BT), 1 ♀. Wadi Darbat: BM 1977.1199, 1 ♀. Tawi Atair: BM 1978.350, (MDG), 1 ♀. 'Salalah': BM 1978.1091, (K. N. CHETWYN).

Arabian *Bitis arietans* have relatively low scale counts compared with most African populations (Parker, 1949) and Dhofar animals fit this pattern: ♂ (n = 1) —D 30, V 128, C 26; ♀ (n = 4) —D 31–33, V 130–137, C 15–18. It is also true of three specimens from North Yemen mentioned by Cherchi & Spano' (1966). This large heavy-bodied viper appears to be restricted to relatively mesic areas. Thomas (1932) found it in well vegetated places on Jabal Qara, and the Wadi Darbat specimen was taken in long grass on a rocky slope. Thomas suggests that it is one of the commonest snakes in the Dhofar mountains.

VERNACULAR. According to Thomas (1932) this snake is called *dololat* in the Qara mountains.

Cerastes cerastes gasperettii Leviton & Anderson

Cerastes cerastes gasperettii Leviton & Anderson, 1967: 183. Type locality: Beda Azan (23°41'N 53°28'E), Abu Dhabi.

DISTRIBUTION. North Africa and Arabia.

MATERIAL. Haylat Ash Shisur, 1,080 ft. (330 m): BM 1930.6.30.19, (BT), 1 ♀; D 32, V 168, C 35. Jiddat al Harasis (19°45'N 56°45'E): BM 1978.351, (MDG), 1 ♂; D 31, V 150, C 36. 'Bawi to Salalah': BM 1975.1030, (W. THESIGER), 1 ♀; D 33, V 162, C 38. 'Salalah to Mukallah': BM 1974.4047–48, (W. THESIGER), 1 ♂, 1 ♀; D 31, V 154, C 40; D 32, V 161, C 35.

The specimens listed here all conform to the description of *C. c. gasperettii*, particularly in their high ventral counts. This also applies to another fifteen Arabian specimens in the British Museum collection but two from the Aden area have only 139 and an estimated 136 ventrals and small supranasals (BM 99.12.13.90, BM 1937.11.1.15).

C. cerastes ranges over the more arid parts of

PLATE 19. *Mesalina ayunensis* sp. nov., at type locality. (Photograph A. Dunsire)

PLATE 22. *Malpolon moilensis*, ♂, 950 mm long, from 20°10′N 57°00′E, Jiddat al Harasis; BM 1978.811. (Photograph British Museum (Natural History), P. A. Richens)

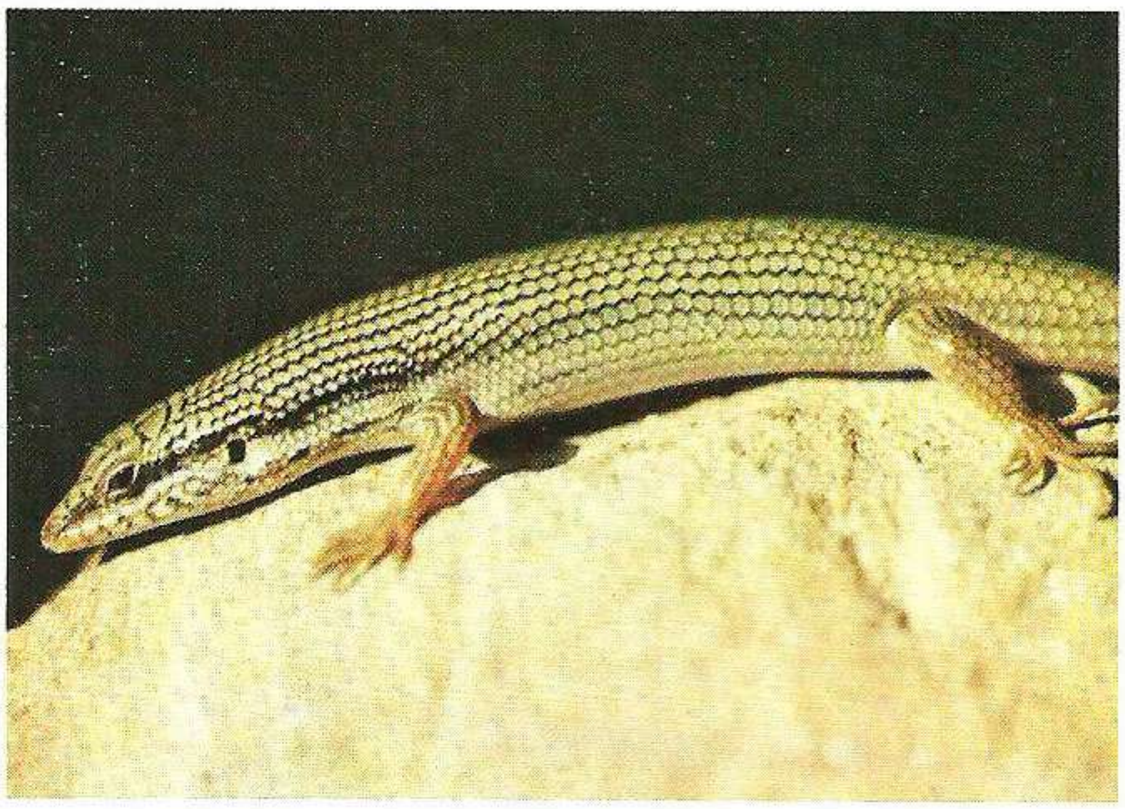

PLATE 20. *Mabuya tessellata* from Wadi Aday, northern Oman. (Photograph M. D. Gallagher)

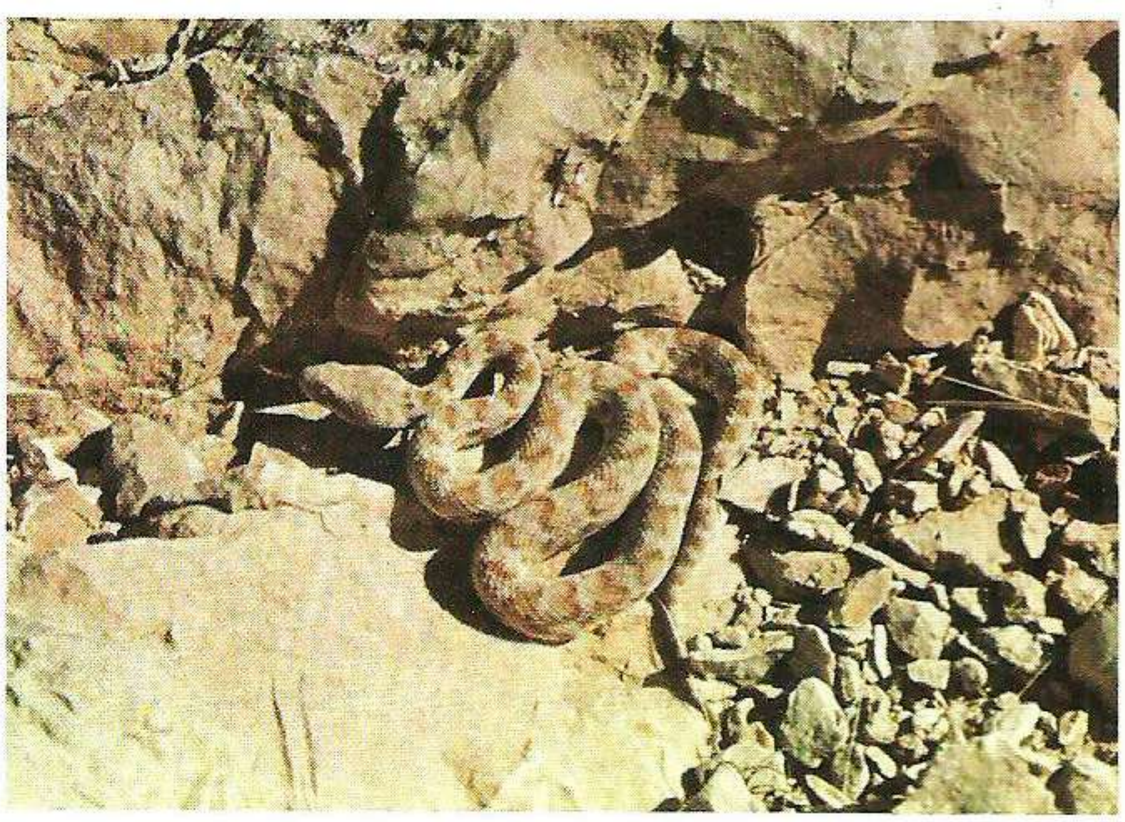

PLATE 23. *Echis carinatus*, ♀, about 750 mm long, at Ayun; BM 1978.1099.

PLATE 21. *Coluber thomasi*, ♂, 389 mm from snout to vent, Khawr Sawli; BM 1977.1193.

PLATE 24. *Echis carinatus*, ♂, about 500 mm long, near Thamarit road 49 km from Salalah; BM 1977.1201.

Arabia and is usually associated with sandy habitats.

Echis carinatus (Schneider) s. lat. *(Plates 23–24)*

Pseudoboa carinata Schneider, 1801: 285. Type locality: Arni (near Madras).

DISTRIBUTION. North Africa, southern Arabia and neighbouring Iraq and Soviet Central Asia, Afghanistan, Pakistan, India and Sri Lanka.

MATERIAL. Ayun: BM 1978.1099, 1 ♀. 49 km from Salalah on Thamarit road: BM 1977.1201, 1 ♀. Zik, near Bu Matahan (17°10′N 54°00′E), 2,000 ft. (620 m): BM 1931.7.16.78, (BT), juv ♂. Wadi Raykhut: BM 1977.1200, 1 ♀. Liqbi (18°16′N 56°34′E): BM 1977.841, (MDG), 1 ♂.

The five specimens of *Echis* known from Dhofar lack the conspicuous very light markings typical of members of the *E. carinatus* complex and the larger individuals have broad, rather flattened heads. In these features, they resemble *E. coloratus* Gunther, 1878 and some of them were collected in habitats often occupied by this species (see p. 323). *E. coloratus* is found both to the west and east of Dhofar, occurring from Egypt through Palestine, Jordan, northern and western Saudi

TABLE 7. Some features varying within the *Echis carinatus* complex. *E. coloratus* is included for comparison. Data from Cherchi & Spano' (1966), Drewes & Sacherer (1974), Hughes (1976), Roman (1972; 1973), Stemmler (1969; 1970) Stemmler & Sochurek (1969) and specimens in the British Museum

		S India	N India – Iran	Northern Oman	Dhofar Province	SW Arabia	NE Africa	W Africa	
	E. coloratus	*E. carinatus carinatus*	*E. carinatus sochureki*	*E. carinatus sochureki*			*E. carinatus pyramidum, E. c. leakyi, E. c. aliaborri*	*E. ocellatus*	*E. leucogaster*
hemipenis with numerous, hard spines in adults (+), or fewer, soft ones (—)		+	—	—	—	+	+	+	+	+
hemipenial spines extend proximally as far as fircus		—	—	—	—	+	+	+	—	+
genial scales large and regularly arranged		—	+/—	—	—	+	+	+	+	+
mid-dorsals with humped keels (Fig. 2)		+	—	—	—	+	+	+	+	+
dorsals in transverse row at mid-body		31–37	27–29	29–38	29–35	29, 31	25–33	25–31	27–34	27–33
ventral scales:	♂	175–205	139–154	158–180	154–166	165, 174	155–177	153–181	134–155	162–175
	♀			162–184	163–169	185	163–189	160–186	134–160	165–184
subcaudal scales:	♂	45–57	23–33	26–37	30–34	36–39	30–48	29–44	21–30	31–38
	♀			26–33	27–33	39	29–38	27–39	17–24	25–33
scale-rows between eye and supra-labial scales one or two		—	+	+	+	+	+	+	+	+
head especially broad		+	—	—	—	+	—/+	—	—	—
no very light markings in pattern		+	—	—	—	+	—	—	—	—
dark spots on belly		+	+/—	+/—	+	—	+/—	+/—	+	—

Arabia, North Yemen and South Yemen as far as Hadhramaut, and as an isolated population in northern Oman. However, in spite of their superficial similarity, Dhofar animals differ from *E. coloratus* in a wide range of features which are listed below with the equivalent *E. coloratus* conditions in parentheses: rostral and nasal scales in contact (often separated), upper labials 10–12 (13–15), subocular enlargement of upper labials usually apparent (weak or absent), eye and upper labials separated by only two scales (three or four scales), anterior upper temporals strongly keeled (weakly keeled), genials large and regular (small and irregular), keels on mid-dorsals extending nearly to scale tips (often rather shorter), snout not especially wide (often broader), dorsum with irregular lighter areas (often a pattern of lighter, well-defined spots along mid-line), ranges of dorsal, ventral and subcaudal scale numbers lower, see Table 7.

In contrast, nearly all the features of Dhofar *Echis* occur in at least some members of the *E. carinatus* complex and it is in this assemblage that the snakes must be placed. In Arabia all other populations are presently assigned to *E. carinatus* itself and, as with *E. coloratus*, they fall into two disjunct groups, one extending from Asir (Gasperetti, 1974) through North Yemen (Cherchi & Spano', 1966) to Aden and eastwards to the Hadhramaut, and the other in eastern Arabia from the eastern United Arab Emirates and northern Oman to Masirah. On present evidence the latter population is geographically closest to that in Dhofar, but shows many points of difference, including the structure of the hemipenis. In mature males from Dhofar this is large with relatively stout lobes terminating in small awns and ornamented with spines that extend proximally to about the level of the sulcal bifurcation. Here they are large and sharply pointed with horny tips but size decreases distally; half way along the lobe there are about 20–30 spines in a radial count. In animals from northern Oman, the hemipenis has slender lobes on which terminal awns are not apparent and ornamentation consists of soft papillae that do not extend proximally as far as the sulcal bifurcation or show marked decrease in size distally; radial counts half way along the lobe are about a dozen or less. In fact the condition of the hemipenis in mature northern Oman *E. carinatus* is very similar to that in immature animals from Dhofar and other areas where the organ is robust with numerous hard-tipped spines in adults. While genial scales are large and regular in Dhofar, they are small and often irregular in northern Oman (this and subsequent features were checked on 29 northern Oman *E. carinatus*). Dorsal scales in the mid-vertebral region of Dhofar snakes have keels with a humped profile, while in northern Oman keels are lower and more even (Fig. 2). As stated, the head may be very broad in Dhofar adults but this is not usually apparent in northern Oman, although it is in one big female (BM 1978.781). In the former region, the top of the head is often largely uniform, there are no very light markings on the body and the belly is immaculate, whereas in northern Oman head patterning is conspicuous, as are light body markings, and in most cases the belly has a broad central band of small dark spots running along it. The ventral and subcaudal scale counts also show differences (Table 7).

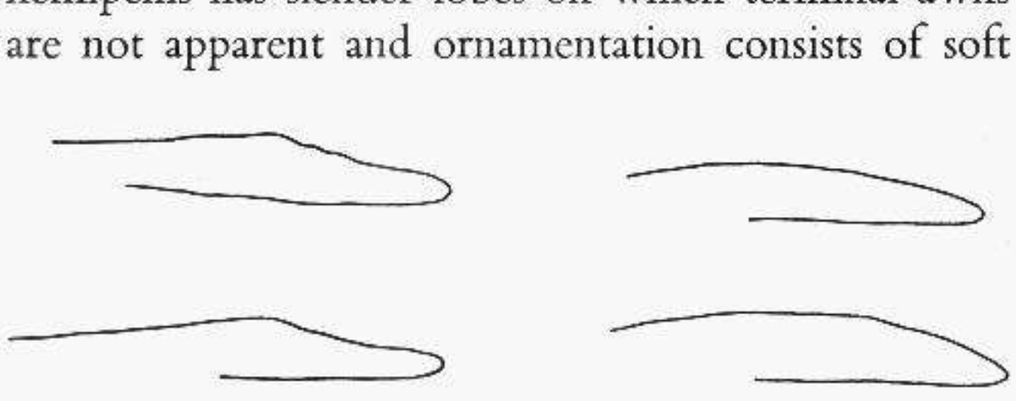

FIGURE 2. *Echis carinatus* complex: profiles of scales from vertebral area of mid-body region. *(Left)*: Dhofar; *(right)*: northern Oman.

The resemblance of Dhofar *Echis* to the *E. carinatus* of south-west Arabia is very much greater and extends to most of the characters listed above. These south-western snakes are, however, not especially broad headed, have less strongly keeled snout scales, and most of them have typical bold *E. carinatus* patterning, but the two specimens from localities nearest to Dhofar (BM 97.3.11.117 from Hadhramaut and BM 1962.1001 from Gheil Bawasir) are coloured like the *Echis* of that area.

It seems then that the *E. carinatus* complex in Arabia is represented by two very different forms and, when members of the group from other areas are examined, it is apparent that both have extensive ranges outside the peninsula. The nearest populations to those in northern Oman are in Iran and snakes from here, south-east Iraq, south Turkestan, Afghanistan, Pakistan and north-west India have been named as a subspecies, *E. c. sochureki* Stemmler, 1969. Although somewhat variable, these populations are similar to northern Oman ones, differing mainly in their often higher scale counts and more variable ventral colouring, and it seems reasonable to refer the latter to *E. c. sochureki* as well. In the rest of India and Sri Lanka snakes are

referred to *E. c. carinatus*, which is characterised by small size, frequent presence of enlarged genials and low counts of body scales, but otherwise resembles *E. c. sochureki*.

Animals from south-west Arabia are similar to those widespread in north-east Africa which are often referred to *E. c. pyramidum* Geoffroy Saint Hilaire, 1827, a name based on Egyptian material. In Kenya, two other subspecies have been named, *E. c. leakyi* Stemmler & Sochurek, 1969 and *E. c. aliaborri* Drewes & Sacherer, 1974; both these are based largely on pigmentation characteristics and it seems probable that nearly all *Echis carinatus* from Egypt to Kenya can be referred to a single rather variable form. Hughes (1976) mentions two Somali animals and one from Sudan with very low scale counts but too little is known of the populations they represent to tell if they should be referred to a separate species.

In west Africa there are two sympatric species of the *E. carinatus* complex to which the names *E. leucogaster* Roman, 1972 and *E. ocellatus* Stemmler, 1970 have been given. Material is lacking from the area between their ranges and that of *E. c. pyramidum* (see *e.g.* Hughes, 1976) so it is uncertain whether one or other of them is conspecific with the latter form. Roman (1973) suggests that *ocellatus* is, and Hughes inclines to this view, pointing out that the ventral and subcaudal counts of *ocellatus* increase clinally from west to east and, if this trend were to continue, ventral numbers would coincide with those of *E. c. pyramidum* where the two populations made contact. However, at the present time, the known counts of *ocellatus* are outside the range of *E. c. pyramidum*, it possesses a pattern of lateral ocelli not found in that form and it has a rather different hemipenial structure in which the spines do not extend back to the level of the sulcal bifurcation; *leucogaster* on the other hand corresponds to *E. c. pyramidum* in scale counts, lack of ocelli and in hemipenial structure, and the immaculate belly from which it gets its name, also occurs in some *pyramidum*. So it may well be that *E. ocellatus* is the independent species.

Notwithstanding the fact that more than one species is involved, African representatives of the *E. carinatus* complex are all like south-west Arabian material in their large, regular genials and humped dorsal scale profiles and nearly all appear to have similar basic hemipenial structure as well, for the condition found in *E. ocellatus* is a relatively minor variant. In a total of 35 African animals checked only one aberrant hemipenis was found; this is of an apparently mature individual from Biskra, northern Algeria (BM 1907.4.6.55) and is similar in structure to the hemipenes of Asian animals.

It seems therefore that Arabia is the meeting place of two distinct geographical sections of the *E. carinatus* complex. In the area of their closest approach in the south-east of the peninsula, the number of differences between them is increased (see p. 321) and is greater than between the two species present in west Africa. So it seems possible that the two forms in Arabia could also act as separate species, especially as there are indications that their habitats are different (below). Unfortunately their status cannot be confirmed, at least at present, for there is a gap of about 360 km between the two forms where no *Echis* has yet been collected.

The systematics of the *E. carinatus* complex is of more than theoretical significance for these snakes are of great medical importance. The severity of their bite coupled with their frequent abundance makes them a serious hazard in many areas. This is aggravated by the fact that venom chemistry seems to vary greatly between taxa and antivenines prepared from one stock may be relatively ineffective against the venom of another. For instance, in north-east Nigeria, antivenine produced from local *E. ocellatus* gave good results whereas those prepared from other populations in the *E. carinatus* complex did not (Hughes, 1976). It would not be unexpected to encounter such differences within Arabia.

In Dhofar, the three *E. carinatus* collected in autumn 1977 were found in the following locations: in a shallow cave opening onto a sloping rock pavement above the pool at Ayun, on a rocky bank with shrubs bordering an irrigated area at Wadi Raykhut and among vegetable flood debris lodged 0.5 m from the ground in a frankincense bush in a shallow stony wadi near the Salalah–Thamarit road. In northern Oman *E. carinatus* occurs frequently on sandy and gravelly plains and is replaced in more precipitous rocky habitats by *E. coloratus*.

Other Reptile Species

It is certain that there are more terrestrial reptiles in Dhofar than the 47 species listed above and, in particular, more forms are likely to be discovered in the poorly known desert regions of the north. Amongst those expected are *Stenodactylus arabicus* (Haas, 1957),

a diminutive gecko of soft sand habitats that is widespread in southern Arabia (Bahrain, Dhahran, United Arab Emirates, Hadhramaut, Al Ajaiz near Masirah), *Acanthodactylus gongrorhynchatus* Leviton & Anderson, 1967, another sand-dwelling species which is known from Dhahran, Abu Dhabi and north-west of Dhofar at 20°20′N 51°42′E, and *Varanus griseus*, the desert monitor, which Thomas collected from about 22°N 51°E. The minute but very widespread snake, *Rhamphotyphlops braminus* (Daudin, 1803) would not be a surprising discovery in the moister areas of southern Dhofar. No sea snakes are recorded, but the pelagic *Pelamis platyurus* (Linnaeus, 1768) is likely to occur occasionally for it has been taken at Aden (Corkhill & Cochrane, 1965) to the west and at Masirah to the east. Sea turtles certainly occur and a Loggerhead (*Caretta caretta*) was seen in an inlet at Wadi Sayq but this group will be reported more fully elsewhere (Ross, 1979; in press; Ross & Barwani, in press). There were also rumours in autumn 1977 of land tortoises at Tawi Atair, but none were ever brought forward.

Arnold (1977) lists *Pristurus flavipunctatus* as occurring in Dhofar. This is based on a specimen that was believed to come from between Bawi and Salalah (BM 1974.4032) but it now appears more likely that the origin was the Hadhramaut area. Certainly no other example of the species has ever been found in Dhofar.

Resource Partition among Dhofar Reptiles

As commonly occurs elsewhere, resource partition among Dhofar reptiles appears to be largely based on the following parameters: time, food type, hunting method and space. This pattern is relatively clear among lizards in southern Dhofar but too few observations are available for snakes to make much useful comment; although poorly studied itself, the lizard fauna of northern Dhofar is very like that of the non-montane areas of the United Arab Emirates where observations suggest the same parameters as in southern Dhofar are important. Discussion here will concentrate on the lizards of the latter area.

TIME

The main division is into forms that hunt by day and those that do so at night. In southern Dhofar geckoes constitute the overwhelming lizard component among night hunters although *Pristurus carteri* is also active by day and *P. minimus* and *P. rupestris* appear to be predominantly diurnal feeders. Among snakes, *Eryx*, *Atractaspis*, *Lytorhynchus* and *Telescopus* are nocturnal whereas *Coluber rhodorhachis*, *Malpolon* and *Psammophis* seem to be usually active by day. The one *Coluber thomasi* encountered was seen at dusk and *Naja* and the vipers may well be active both by night and day according to the season. To date there is no evidence of very marked temporal differences within the diurnal and nocturnal communities.

FOOD

The two species of *Uromastyx* are vegetarian when adult but other lizards feed substantially on invertebrates, although a number take a proportion of vegetable food as well (*e.g.* agamids, *Chalcides ocellatus*, *Scincus mitranus*). Among the invertebrate feeders, there seems to be little real specialization, lizards taking whatever palatable items they can overpower, but, as there are considerable differences in body size and microhabitat between species, actual diets vary considerably.

HUNTING METHOD

Predatory diurnal lizards fall into two main classes: those hunting actively, often using olfactory and auditory cues as well as sight, and mainly visual hunters that sit and wait for food to pass (Pianka, 1966). Lacertids and skinks are typical of the first type and agamids of the second, although the two categories are not entirely clear cut (see *e.g.* Arnold & Gallagher, 1977). The nocturnal geckoes are harder to categorize, partly because it is not easy to observe their hunting methods in the dark. Certainly, forms like *Hemidactylus t. parkeri* will forage in a typical sit and wait manner, especially near lights which attract prey; *Pristurus carteri* also often employs this method. In the

KEY TO TABLE 8

1–2 Arid regions: 1, soft substrates *e.g.* aeolian sand; 2, hard substrates *e.g.* gravel.
3–5 Dry-mesic regions in which frankincense trees (*Boswellia*) often grow: 3, drier areas *e.g.* Thamarit vicinity; 4, areas close to monsoon region *e.g.* around Ayun; 5, in and around wadis with water *e.g.* Ayun pool.
6 Habitats dependent on monsoon: forested seaward slopes of mountains, and grassland above them.
7 Man-made environments: buildings and plantations.

TABLE 8. Distribution of Dhofar reptiles and amphibians by general habitat. (It is probable that some of the species have more extensive habitat ranges than indicated here.)

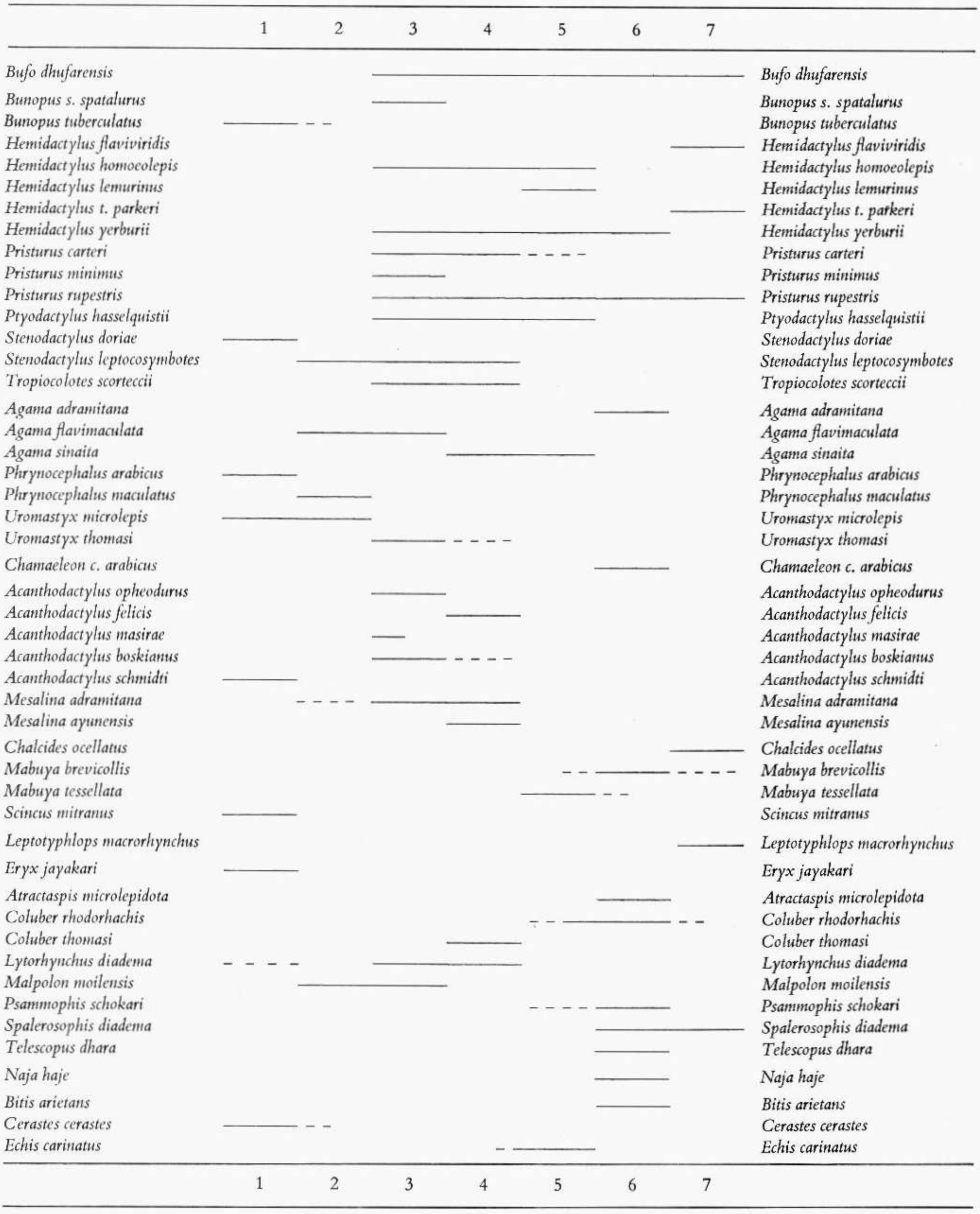

TABLE 9. Some apparent niche differences between lizard species in the dry-mesic habitats of southern Dhofar

NOCTURNAL FORAGERS					
ground dwelling	small prey; on gravel, hard sand *etc.*				*Tropiocolotes scorteccii*
	larger prey	very rough surfaces			*Bunopus spatalurus*
		sand/gravel *etc.*			*Pristurus carteri*
		sand			*Stenodactylus leptocosymbotes*
mainly climbing (on rocks *etc.*)	small prey; on or near ground				*Hemidactylus homoeolepis*
	larger prey	quite near ground, often on pavement			*Hemidactylus yerburii*
		rather higher, usually on smooth boulders			*Hemidactylus lemurinus*
		often higher still, on boulders and large rock-faces			*Ptyodactylus hasselquistii*
DIURNAL FORAGERS					
vegetarian					*Uromastyx thomasi*
small invertebrate feeders					
essentially active hunters	ground dwelling	gravel			*Mesalina ayunensis*
		sand with gravel			*Mesalina adramitana*
		small sandy wadis *etc.*			*Acanthodactylus felicis*
		more extensive sand areas	larger		*Acanthodactylus boskianus*
			smaller		*Acanthodactylus opheodurus*
	mainly climbing on rocks, usually near water				*Mabuya tessellata*
essentially 'sit and wait' hunters	small prey	low climber in rocky places			*Pristurus rupestris*
		sandy places			*Pristurus minimus*
	medium-sized prey	gravel			*Agama sinaita*, young
		sand/gravel *etc.*			*Pristurus carteri*
	larger prey	low climber in rocky wadis			*Agama sinaita*
		partial climber in arid gravel and sand areas			*Agama flavimaculata*
		climber in wadi vegetation near water			*Chamaeleo c. arabicus*

United Arab Emirates some ground-dwelling geckoes like *Stenodactylus arabicus* and *S. khobarensis* also use sit and wait strategies but may change their 'observation posts' very frequently. *S. leptocosymbotes*, *S. doriae* and *Bunopus spatalurus* sometimes sit and wait but also spend long periods walking very slowly on extended legs. Possibly this is really a mobile version of the sit and wait method, enabling large areas to be scanned in situations where particularly favourable hunting perches do not exist. It seems probable that geckoes employ a range of strategies but that they are all predominantly visual. Not enough is known about hunting in the Dhofar species to assess the importance of different methods in avoiding competition.

SPATIAL SEPARATION

Table 8 shows the distribution of Dhofar reptiles and amphibians by general habitat, so far as it is known. Although further observations will undoubtedly increase the known habitat range of some forms, this factor appears to be very important in separating related species, for instance members of *Stenodactylus*, *Agama*, *Phrynocephalus*, *Uromastyx*, *Acanthodactylus* and the Viperidae. In many cases, species are confined to one or two general habitats, but a few like *Bufo dhufarensis*, the *Hemidactylus yerburii* complex and *Pristurus rupestris* are quite wide ranging.

Within each general habitat there are substantial differences in the spatial niches occupied and these are summarized in simplified form for dry-mesic habitats in Table 9. The most important aspects of the structural environment in niche separation are substrate type and, in climbers, height above ground, but proximity to water is also significant in some cases. Differences in substrate and distance from the ground in four species of climbing gecko are shown in Table 10.

TABLE 10. Observed spatial niche differences among climbing geckoes at three sites in Dhofar. Distance from ground is position of lizard when first seen. Substrate categories are somewhat arbitrarily defined as *cliffs* – steep, more or less continuous rock faces, *boulders* – isolated rock masses up to about 4 m diameter, *pavement* – level or gently sloping, more or less continuous rock faces, *ground* – various surfaces from sand and gravel to fine scree

DISTANCE FROM GROUND (m)	Ayun				Wadi Sayq			Wadi Raykhut	
	hom	*yer*	*lem*	*Pty*	*hom*	*yer*	*Pty*	*yer*	*Pty*
4.5+				1			1		
4.5				2			1		
4.2									
3.9									
3.6							1		
3.3				4					
3.0				3			2		8
2.7									
2.4			1					1	2
2.1			2						
1.8		2	5	1	3		2		3
1.5			3	5		4	1		4
1.2		3	15	4	4	3			1
0.9		2	7	2	4	7		4	2
0.6	2	5	6	3	7	4		8	
0.3	6	12	4	7		2		4	1
0.0	39	17	3	2	1			7	

SUBSTRATE	Ayun				Wadi Sayq			Wadi Raykhut	
	hom	*yer*	*lem*	*Pty*	*hom*	*yer*	*Pty*	*yer*	*Pty*
cliffs	4		1	17	8	9	5	3	12
boulders	3	14	40	11	10	11	3	11	8
pavement	17	26	2	2				6	1
ground	22	3	2	4	2			4	

KEY: *hom – Hemidactylus homoeolepis; yer – H. yerburii; lem – H. lemurinus; Pty – Ptyodactylus hasselquistii.*

Although there are similarities, the apparent pattern of resource partition in the reptiles of the dry-mesic zone of southern Dhofar is very different from that found in the mountains of northern Oman (Arnold & Gallagher, 1977). This is partly because the areas are not precisely comparable: the northern Oman mountains allow considerable altitudinal separation of species but the areas examined by Arnold and Gallagher do not possess much of the more open, flat habitats frequent in Dhofar. However, such environments exist in the hinterland of the mountains and, if this is taken into account, the overall resemblance is greater, for the hinterland is inhabited by such forms as *Stenodactylus leptocosymbotes*, *Agama flavimaculata*, *Uromastyx microlepis*, *Mesalina adramitana* and *Acanthodactylus boskianus* which do not occur in the mountains themselves.

Differences in resource partition probably also result from the dissimilar composition of the two faunas (see p. 328). Occasionally different species in the two areas have similar niches but this resemblance is rarely precise. For instance *Phyllodactylus gallagheri* of northern Oman is similar in size, superficial appearance and habitat to *Hemidactylus homoeolepis* but it climbs considerably more. Likewise *P. elisae* may occupy similar habitats to *H. lemurinus* but also occurs

in situations like those of *H. yerburii* at Ayun. Some of the differences between such partial analogues are probably related to their different ecological potentials but others may well result from the different patterns of competition encountered. Some evidence for this last factor is provided by species that occur in both areas. In a number of cases the ecological space occupied in northern Oman and Dhofar appears to be different and in such instances the differences appear to be related to the presence of a competitor in one region but not the other. Thus *Bufo dhufarensis* is largely excluded from wet areas in northern Oman by *B. orientalis* but is common in such habitats in Dhofar; *Bunopus spatalurus* occupies gravelly areas in northern Oman but is replaced in such environments in southern Dhofar by *Pristurus carteri*; *Mesalina adramitana* occurs both on sandy ground and on gravel in northern Oman but is replaced on the latter substrate in Dhofar by *M. ayunensis*; *Echis carinatus* in northern Oman is typical of sandy and gravelly plains while *E. coloratus* occurs largely in rocky places often near water, but in Dhofar, where the latter species is absent, *E. carinatus* is found in such environments.

Regional Affinities of the Dhofar Reptile and Amphibian Fauna

The geographical affinities of the higher taxa present in Dhofar will not be dealt with here. To approach this problem adequately the herpetofauna of Arabia and neighbouring regions would have to be considered as a whole and the phylogeny of the groups concerned assessed, both tasks being outside the scope of the present paper. Instead, discussion will be limited to the species occurring in Dhofar and, where necessary, their closest relatives in other areas.

The forms present in Dhofar have total ranges that fall into a number of patterns.

1. Wide distribution in the desertic regions of inland Arabia: *Bunopus tuberculatus, Stenodactylus doriae, Uromastyx microlepis, Phrynocephalus arabicus, P. maculatus, Acanthodactylus schmidti, Scincus mitranus, Eryx jayakari, Lytorhynchus diadema, Malpolon moilensis, Psammophis schokari* and *Cerastes cerastes.*

2. Peripheral, mainly coastal distribution in Arabia, usually associated with man; also in neighbouring areas: *Hemidactylus flaviviridis, H. turcicus* and *Chalcides ocellatus.*

3. Widely distributed in less arid parts of Arabia and in north Africa and south-west Asia as well: *Coluber rhodorhachis, Spalerosophis diadema.*

4. Widely distributed in less arid parts of Arabia and in north Africa but not, or scarcely, extending into Iran region: *Ptyodactylus hasselquistii, Acanthodactylus boskianus, Telescopus dhara.*

5. Relatively mesic environments of south and often west Arabia but not extending east of Dhofar; conspecific populations or close relatives in Africa: *Hemidactylus yerburii, Tropiocolotes scortecii, Agama adramitana, Mabuya brevicollis, Atractaspis microlepidota, Bitis arietans, Echis carinatus pyramidum.*

6. Widely distributed in less arid parts of Arabia with limited penetration into north-east Africa: *Agama flavimaculata, A. sinaita.*

7. Widely distributed in less arid parts of Arabia with no penetration into Africa: *Bufo dhufarensis, Acanthodactylus opheodurus.*

8. Restricted distribution in southern Arabia: *Hemidactylus homoeolepis, Pristurus carteri, Acanthodactylus felicis.*

9. Oman to Yemen with related species in Iran: *Bunopus spatalurus, Mabuya tessellata.*

10. Lowlands of Oman south-west to Hadhramaut: *Stenodactylus leptocosymbotes, Mesalina adramitana.*

11. Dry coastal lowlands of south-east Arabia from Masirah Island to the dry-mesic area of south-west Dhofar: *Pristurus minimus, Acanthodactylus masirae, Uromastyx thomasi.*

12. Possible Dhofar endemics: *Hemidactylus lemurinus, Mesalina ayunensis, Coluber thomasi.*

As elsewhere in Arabia, the most obvious division is between the desert forms widespread in the peninsula (1) and the various peripheral elements (2–12). In Dhofar the former predominate in the north but are largely replaced by the latter to the south. The peripheral elements are very varied in their affinities but a much higher proportion of them are conspecific with, or related to, species in south-west Arabia than to ones in northern Oman. This is true of the species in groups 5 and 8, and of the subspecies of *Bunopus spatalurus* found in Dhofar; the closest relative of *Coluber thomasi* is also in south-west Arabia.

The differentiation of southern Dhofar from northern Oman is particularly marked, for the latter area has

at least nine species that do not extend into south Arabia (Arnold & Gallagher, 1977) and to these may be added *Bunopus spatalurus hajarensis* and *Echis carinatus sochureki*. One reason why these two relatively mesic areas should have such different faunas is the presence of the arid lowlands that reach the coast of south-east Arabia between the two. Climatic conditions here, together with the reptile community adapted to it, would certainly block the spread of many forms. However, a few species that apparently need quite mesic conditions occur both in Dhofar and northern Oman, for instance *Mabuya tessellata* and *Coluber rhodorhachis*, which suggests that possibly the arid lowlands once had a more favourable climate. However, if such a more mesic corridor existed it would be necessary to explain why so many forms failed to make use of it; some suggestions about this are given by Arnold & Gallagher (1977).

The dry lowlands of Oman also show indications of endemicity in the species in groups 10 and 11. All these belong to assemblages that occur quite widely in Arabia and they may indicate that in Oman this community was isolated from the rest of the peninsula for a time.

It is interesting to note that the forested areas of south Dhofar have no endemic reptiles or amphibians or even relict populations of forms known from the mesic highlands of Yemen and northern Oman. However, with hindsight it seems over optimistic that they should ever have been expected. The south Dhofar mountains are not especially large, so their orographic effect must not be overestimated. The area that gets moisture from the south-west monsoon at present is very small and it is probable that even slight perturbations in meteorological conditions could result in more arid periods that would exterminate any form really dependent on moisture. Indeed, even now the forest is dry for a substantial part of each year. An indication that the area has not always been so well watered is provided by the distributions of *Bufo orientalis* and *Echis coloratus*, both forms that appreciate moisture. As these occur both in south-west Arabia and northern Oman it is very probable that they were once present in the intervening area including Dhofar, yet they do not appear to be there now and, as there are no competitors present that are likely to have displaced them under relatively moist conditions, it seems possible that they succumbed to a transient dry period. At present the forested areas are occupied by widespread essentially African species in group 5 which are typical of savannah areas and by ecologically labile opportunistic forms like *Bufo dhufarensis* and *Pristurus rupestris*, all taxa that may have colonised the forest relatively recently and give no indication of great age.

What reptile endemicity there may be in Dhofar appears to be related to the dry-mesic communities best developed on the northern side of the mountains, although too little is known about the fauna of eastern South Yemen to be absolutely sure that any of the three species listed in group 12 are really restricted to southern Dhofar and its immediate vicinity. Nevertheless, it is possible that the mountains have attracted enough moisture to support a dry–mesic fauna long enough to differentiate at the species level even if no really mesic environments have been continuously maintained.

Further Collecting

Suggestions for further collecting in Oman have been made elsewhere (Arnold & Gallagher, 1977) but reviewing the Dhofar fauna makes it clear that there is still much to find out about this province, particularly the habitats between the monsoon area and the desert regions of the north. The present Survey also underlines the importance of the poorly known dry lowland country that lies between Dhofar and the mountains of northern Oman. Investigation of this may throw light on how the faunal differentiation between the two regions it separates has evolved and been maintained. It might also clarify some specific systematic problems such as the relationship of the two subspecies of *Bunopus spatalurus* and the status of the two kinds of *Echis carinatus* found in Arabia.

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Footnotes

[1] This is usually regarded as a subspecies of *H. arborea* but its call is very different from that of populations assigned to this form (see for instance Schneider & Nevo, 1972) and *H. savignyi* is therefore likely to be a good independent species.

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