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

EDITORIAL

For the greater part of its existence Dr. A. d'A. Bellairs has been the editor of the *British Journal of Herpetology*.

For many years, notwithstanding his many distinguished activities in teaching, research and authorship, he has devoted much time and effort in dealing with the multitude of problems associated with editorial work.

The object of the Journal has been to tread the delicate path in publishing a wide variety of herpetological articles, from, on the one hand the enthusiastic naturalist and, on the other the more professional academic research worker.

With this end in view Angus Bellairs has successfully managed, so to speak, to bring both ends of the spectrum together, for in the pages of the Journal the "twain actually met". It is probably true to say that, with his kindliness, tolerance and unrivalled knowledge and experience of all things herpetological, he was one of the few who could have done it.

For the simple reason of too much work, Bellairs has had to relinquish the sole editorial responsibility. However with his customary generosity he has agreed to act in an advisory capacity, a decision greatly valued by all who have the interests of the Journal at heart.

All members of the Society, contributors and readers alike offer their sincere thanks to him for all he has done in the interests of Herpetology.

THE ORIGIN OF THE VERTEBRATE PRONEPHRIC DUCT

By

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(*Received* 10/9/65)

For more than half a century standard textbooks of zoology and embryology have taught that the nephric system of vertebrates, from excretory unit as far as urinary bladder, is derived from embryonic mesoderm and from nowhere else. One current textbook says this is a fact which is "universally recognized". In his distinguished book *The Life of Vertebrates* Professor J. Z. Young describes the nephridia of *Amphioxus* in these terms: "In development these remarkable organs arise from groups of cells close to the meeting place of ectoderm and endoderm; almost certainly they are derived from the former. They have no relation to the mesoderm, and this fact alone sufficiently indicates that they are in no way comparable to the pronephros of vertebrates, as is sometimes stated."

Statements as definite as these are not made in science unless there is thought to be powerful and compelling evidence to support them. But their very dogmatism ought to make one a little uneasy. An account of accepted views on the development of the pronephros was given recently by Fox (1964) in this journal, together with an indication of experimental evidence that he and Dr. Hamilton had obtained, which led them to doubt some aspects of the "received" account.

Some years ago (Towers 1958), when studying transverse serial sections through a 23-somite sheep embryo, I came across a feature illustrated in the text-figure.

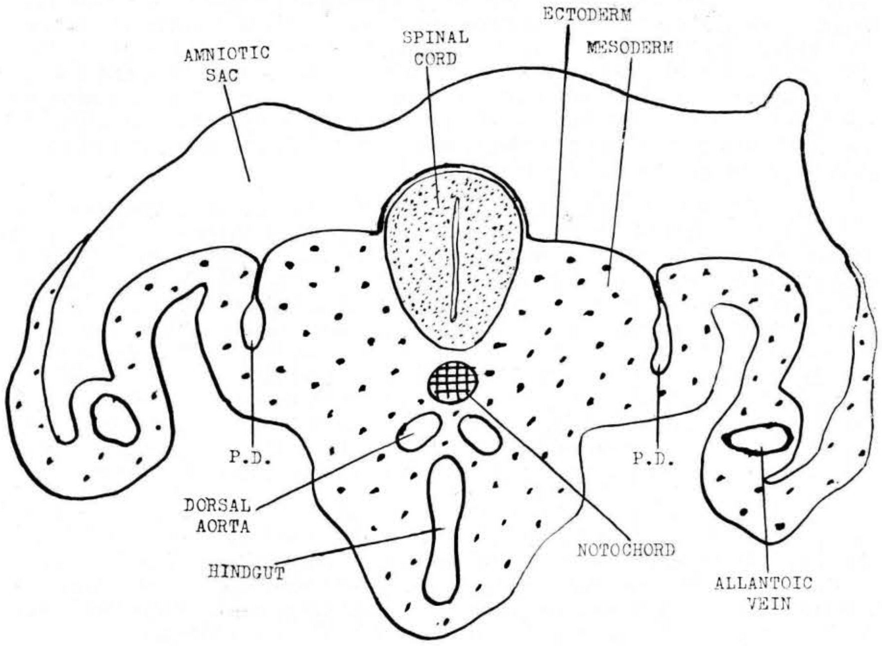


Figure 1.

The structures labelled P.D. I interpreted at first as a fixation-artifact caused by folding of the dorsal part of the embryo. This, I thought, had led to the formation of a "gutter" which had become a "canal" owing to approximation of the lips of the groove. Out of curiosity I followed the serial sections up and down, expecting at any moment that the "lumen" would open up into the amniotic sac. To my astonishment the structure turned out to be the pronephric duct. Proximally it received pronephric and mesonephric tubules, and looked to have no association with ectoderm, being separated from it by a thick layer of mesenchyme. On its way caudally to the cloaca the duct gradually approached the ectoderm. Eventually its lining epithelium was seen to be not merely in contact, but in direct continuity, with the surface-ectoderm. It seemed impossible that this appearance was the result of a secondary association. A more reasonable hypothesis was that the duct primordium was in fact an ectodermally-derived structure. The reason for the startling appearance in the sheep was, perhaps, the early onset in that species of mesonephric function, causing dilation of the duct before it had had time to "hive off" the ectoderm throughout its length.

The history of conflicting views about the origin of the pronephric duct goes back almost a century. In 1867 the great Hensen stated that he had been able to verify directly, in guinea-pig embryos, that the duct was developed by invagination of ectoderm "as assumed by His". The assumption, or hypothesis, of His was logically sound, because it provided a theory which linked the excretory system of vertebrates with that of invertebrates. In the latter each nephridion opens independently on to the surface by a duct which is unquestionably of ectodermal origin. This theoretical aspect was still referred to in the 1911 edition of Quain's Anatomy, but was subsequently lost sight of until Willmer (1960) revived it, in quoting observations of the present author.

Graf Spee (1884) and Flemming (1886) gave evidence of an ectodermal origin of the duct in guinea-pig and rabbit. But Lockwood (1887) in this country, no doubt influenced by the monograph in which Balfour (1878) had postulated a mesodermal origin of the duct in elasmobranch fishes, produced a scathing attack on their views, for which he was subsequently taken to task by Field (1891) in a very careful paper. Perenyi (1887) noted a clear ectodermal contribution in *Rana esculenta* and *Lacerta viridis* but, as with some others who published observations on the problem, he upset his case, and set the stage for heated controversy, by saying that not only the duct, but the nephric ridge as a whole, was derived from ectoderm. This has been proved beyond any shadow of doubt not to be true.

The year 1888 saw many publications on this topic. Ectodermal support was as follows: in selachians from Van Wijhe and Rückert; in sheep from Bonnet; in guinea-pig from Keibel (thus reversing his earlier conclusions on hedgehog); in Chelonia (*Emys japonica* and *Trionyx japonica*) from Mitsukuri. The same year saw the publication of a paper whose subsequent influence has far outstripped its intrinsic merit. Martin studied rabbit embryos. He concluded that the duct grew out from mesoderm, and that it merely indented the surface-ectoderm until its freely-growing tip "faded out" just under the surface. He said that others were wrong in thinking that ectoderm actually contributed to the duct, and put forward his own views with great vigour. Unhappily, much of his material was of rather poor quality, and in one crucial specimen (which he said demonstrated the very tip of the growing duct) a fracture of the ectoderm had occurred at the very point in question!

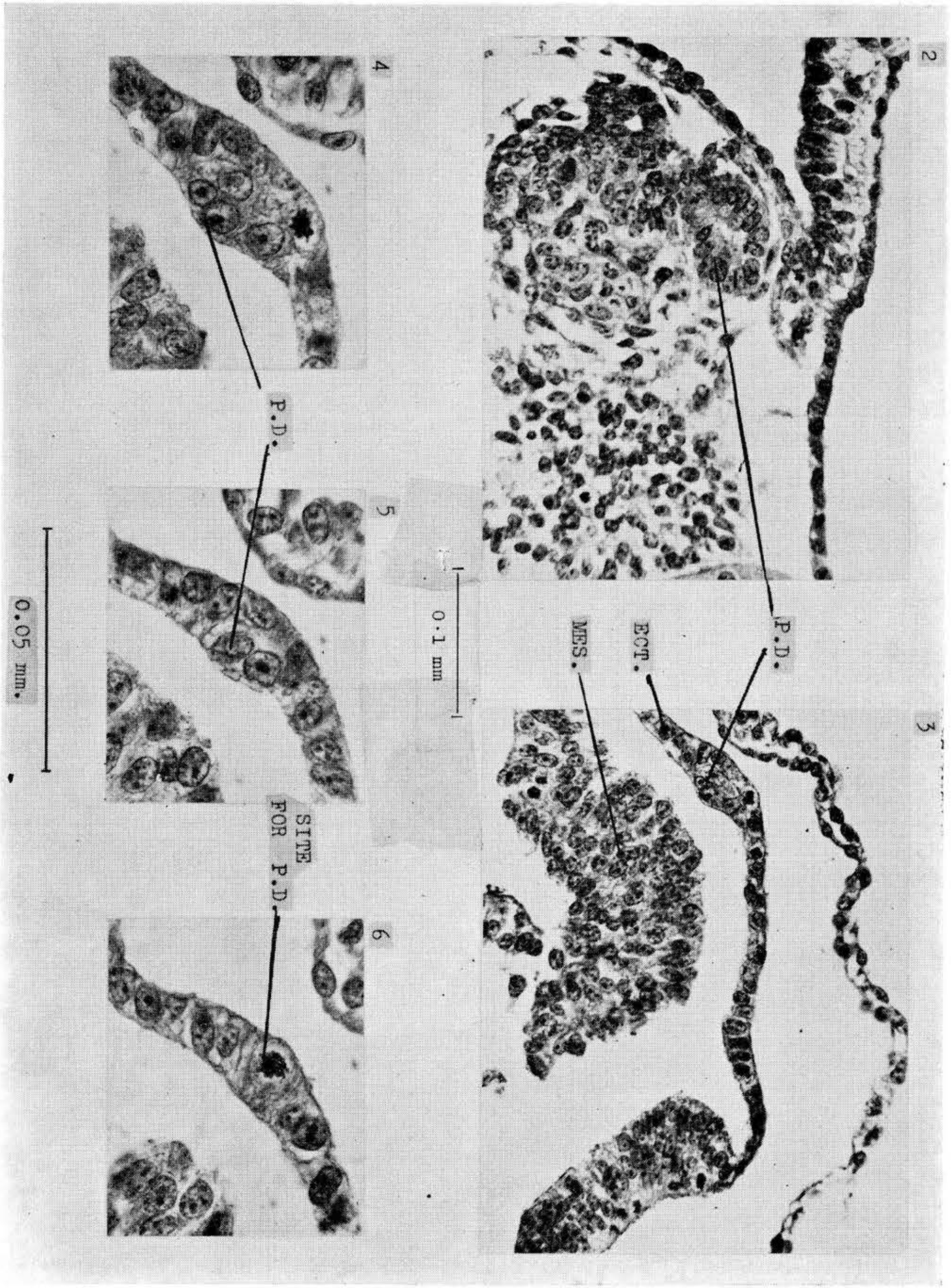
Working on human embryos Meyer (1890), Hertwig (1890) and Kollman (1891) held to the ectoderm theory, as also did Laguesse (1891), again on selachians. But Field (1891), whilst agreeing with the evidence on selachians, said Martin had now thrown doubt on the theory so far as mammals were concerned. He went on to describe how, on the basis of the distribution of cellular yolk-granules, he had come to the conclusion that in amphibia the duct arose from mesoderm.

Marshall (1893) effectively established an orthodoxy in this country by accepting, in his *Textbook of Embryology*, all the evidence for mesoderm, and rejecting that for ectoderm. It should be remembered that this was a period when "the germ-layer theory" was sacrosanct, each embryonic layer being thought of as a wholly distinct entity. Rabl (1896) gave support to mesoderm in the one group (selachians) where hitherto observers had been in complete agreement. However, he was quickly followed by Gregory (1897), also working on selachians, who came to two conclusions which my own mammalian material indicates are probably correct, namely (1) the duct primordium arises, opposite the mesodermal anlage of the cranial pronephric segments, from surface ectoderm from which it quickly separates, and (2) it grows down towards the cloaca in intimate contact with ectoderm, from which it may receive some cellular contribution.

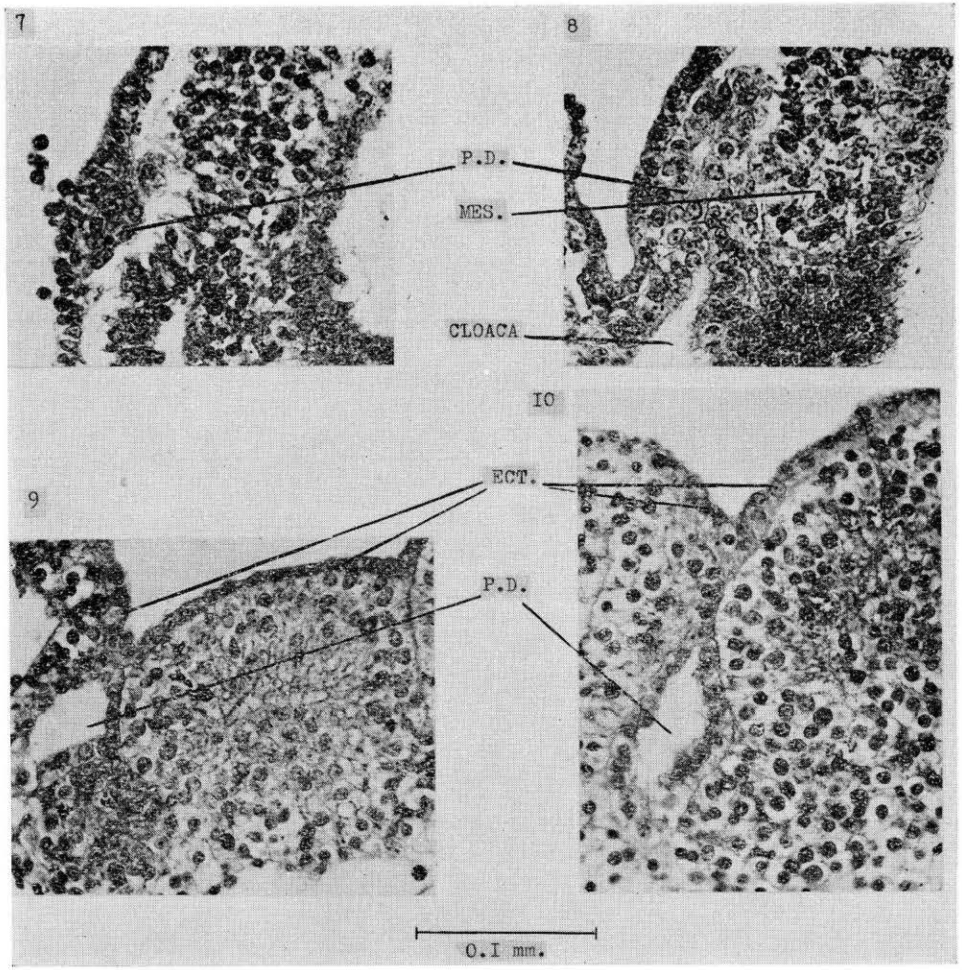
In a series of papers Burlend (1912, 1913, 1914) offered his views on a "matter which has so far defied satisfactory explanation, and upon which the best authorities are by no means unanimous". He argued for mesoderm in *Chelona viridis*, *Chrysemys marginata* and *Scyllium canicula*. The final seal of orthodoxy was placed on the mesoderm hypothesis by Felix's (1912) contribution to the very influential Keibel and Mall's *Manual of Human Embryology*. This author concluded: "I cannot settle definitely the question as to the participation of the ectoderm in the formation of the excretory duct, but I am inclined to deny any such participation."

Ever since then such participation has been completely denied by virtually everyone. Occasionally a hint of a doubt has been expressed. Thus Davies and Davies (1950) said very cautiously that the duct, having arisen from mesodermal pronephric tubules, "becomes intimately related to the ectoderm from which it possibly receives a contribution of cells". But generally everyone seems to have been relieved that "authority" had finally ended what had seemed to be an interminable controversy.

The work most frequently quoted now is that of O'Connor (1938), which Dr. Fox recently summarised in the pages of this journal. O'Connor concluded that



Figs. 2-6



Figs. 7-10

his amphibian marking-experiments settled two points beyond further dispute: (1) the duct grows by free terminal budding, and not by incorporation of cells adjacent to it along its length, and (2) it develops from mesoderm and merely "indents" the ectoderm. The first conclusion must now be regarded, in the light of the experimental findings of Fox and Hamilton (1964), as being *sub judice*. With regard to the ectoderm:mesoderm controversy, it is clear that O'Connor's marking techniques involved both layers. The stained ectoderm was naively regarded as providing a convenient indication of the site of the operation, but clearly that is not the only possible interpretation.

The pronephric duct is of vital significance in the life-history of any vertebrate. Apart from its importance where there is a functional pronephros, it forms the inducing agent for the development of the mesonephros (Boyden 1932, Waddington 1938). In higher vertebrates an outgrowth from this same duct acts as the inducing agent for the formation of metanephric tubules. It is likely that most cases of renal agenesis in human babies at birth are due to failure of development of the duct as early as the end of the third week after fertilization. Some mammals can survive the intrauterine period of development without any excretory system, because of the efficiency of the placental transfer. But, of course, total absence of the kidneys is incompatible with independent existence outside the womb.

It is interesting that induction of nephric tissue has been achieved experimentally (Gruenwald 1943) with nervous tissue, which is itself derived from surface ectoderm. Although it is dangerous to argue from abnormal inductors, yet if the pronephric duct is in fact normally derived like nervous tissue, we may have a unifying theory which solves otherwise intractable problems of nephric evolution.

It may be that the duct forms from an ectodermal placode, and grows back rapidly, as is the case with the lateral-line canals. The illustrations to Stone's (1933) paper on the embryology of these organs in Amphibia show remarkable resemblances to the pronephric duct primordia in sheep illustrated in this paper.

The evidence here presented, as drawing and microphotographs of normal embryological material (Figs. 1-10), requires support from experimental procedures. Though it is hazardous to argue from one class of vertebrates to another, there is perhaps less danger when one is investigating a system so fundamental to biological economy as the one we have been considering. It may be that the current experiments of Fox and Hamilton will, if correctly interpreted, provide convincing proof concerning an embryological problem that has not yet been solved as conclusively as the textbooks make out.

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EXPLANATION OF FIGURES

Microphotographs by Mr. J. F. Crane of the Department of Anatomy, the University of Cambridge.

Fig. 1 Drawing of a transverse section through the hinder region of a 23-somite sheep embryo. The pronephric duct in this region has not yet "hived off" the surface ectoderm, with which its lining cells are seen to be in continuity (see also Fig. 10).

The remaining illustrations are of the area corresponding to the left part of this drawing, to show the pronephric duct (P.D.) at different levels in embryos of different ages, and its relation to ectoderm (Ect.) and mesoderm (Mes.).

Fig. 2 At the 11-somite stage the P.D. in its cranial portion is already separated from surface-ectoderm by the ingrowth of mesodermal cells. This appearance forms the basis of the orthodox theory of a mesodermal origin of the duct.

Fig. 3 More caudally in the same embryo the primordium of the duct is seen to be developing in the surface-ectoderm.

Fig. 4 A higher magnification of Fig. 3.

Figs. 5 and 6 The same specimen as Fig. 4, respectively two and eight sections (each 6μ thick) further down the series, to show the contribution of ectoderm to the "growing tip" of the pronephric duct.

Fig. 7 At the 17-somite stage, a little above the cloaca, the P.D. is still a solid rod of cells intimately associated with ectoderm.

Fig. 8 More caudally, the same specimen shows a contribution to the duct primordium of cloacal endoderm, as described in *Xenopus laevis* by Fox and Hamilton (1964). There is no evidence of a mesodermal contribution.

Fig. 9 At the 21-somite stage the duct has canalised. In the caudal region illustrated the lining-cells of the duct are still in continuity with surface-ectoderm; more proximally the duct has "hived off", and looks to be associated only with mesoderm.

Fig. 10 This shows the appearance in a 23-somite embryo from which Fig. 1 was taken. In the region illustrated the duct is slung from the surface by a "mesentery" formed of typical ectodermal epithelium.

NOTES ON PERSIAN TURTLES

By

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(*Received* 14/6/65)

The findings recorded in this paper were made on the Oxford University Expedition to Northern Persia in July-September 1963, being incidental to a study of soil environment relationships in the Northern Zagros Mountains. Additional observations made on the overland journey through Turkey are also recorded.

The zoogeographic affinities of Persian turtles and other reptiles are discussed by Anderson (1963), who also furnished a bibliography of Persian reptiles. Rough range maps for the tortoises are provided by Obst & Meusel (1963). Formal descriptions of the species are given by Boulenger (1889).

Five full species have been recorded from Persia: *Mauremys* caspica*, *Emys orbicularis*, *Testudo graeca*, *Testudo horsfieldi* and *Trionyx euphraticus*. The last species only just enters the country in Khuzistan Province (Mertens 1957). Two subspecies of *Testudo graeca* occur in Persia—*ibera* in the west and *zarudnyi* in the east. The subspecies *rivulata* of *Mauremys caspica* is not found in Persia, but some specimens were found in Turkey on the outward journey. *Testudo horsfieldi* is not found west of the Caspian Sea, and no specimens were found on the present survey.

Mauremys caspica caspica. Recorded range: western Persia, extending north into Armenia and Dagestan, south at least to Shiraz, and in north-east Arabia at least to Bahrein; eastwards through Iraq into Eastern Turkey, where it is replaced by *Mauremys caspica rivulata*. The population of these turtles in the vicinity of Kermanshah is very homogeneous; however two specimens in the British Museum from Shiraz show a markedly different plastral pattern, which consists of an approximately symmetrical arrangement of large black spots, usually two on each lamina; there also seem to be differences in the age, or rather size, at which the carapace laminae lose the juvenile wrinkling, and it appears likely that a thorough survey will reveal interesting geographically-correlated differences. For this reason a detailed description of the population from the three localities given below is given, several dozen specimens being examined in detail, while several hundred were seen without being caught.

> Carapace approximately oval, depressed, slightly tapered and pinched in supracaudal region. Poorly defined central keel distinguishable on first and fifth centrals. Surface smooth in adults, wrinkled and with traces of lateral keels in juvenile specimens. Nuchal relatively large, much wider posteriorly than anteriorly. Marginals 22, supracaudals 2. Centrals wider than long, constricted between first and second and between fourth and fifth. Plastron moderately large, rigid, gulars paired, truncated or slightly notched anteriorly. Hind margin of plastron deeply notched. Axillary and inguinal large, unbroken, well separated. Head moderate, jaws finely serrated, bicuspid anteriorly. Forelimbs flattened, several enlarged scales on anterior face, five claws. Hind limb with four claws. Tail long.
>
> Plastron predominantly black, with yellow markings, of variable thickness but always present, along seams. Bridge basically yellow, with a row of black spots along submarginals, two to each lamina, and with black streaks more or less confined to the seams. Carapace with vermiculated pattern of red-brown and olive-green. Head basically olive-green, unmarked above except in the juvenile, when it bears an asymmetrical pattern of light lines. Yellow streak from nostril

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*for the use of *Mauremys* rather than *Clemmys*, see: McDowell (1964) to eye, continued behind eye and along neck. Broader streak from nostril to eye ending below eye. Whitish line extending downwards from nostril to cusp of jaw, and continued along jaw. Faint whitish line between this and the line ending below eye. Lower jaw marbled with white markings, forming longitudinal lines along neck posteriorly. Neck with numerous pale yellow lines, becoming confluent above, and much broader in shoulder and axillary region. Forelimbs dark olive-green with yellow stripes, two particularly broad ones, confluent for most of their length, extending to inside two digits. Hind limbs and tail with coarse pattern of yellow and olive-green. Normal adult length 20 cms.

The distinguishing characters of this race given by Loveridge and Williams (1957) were all found to hold good.

The species was abundant in all localities where it was found; basking aggregations of up to a dozen were seen. All turtles were quite capable of swimming, in contrast to the non-swimming population of this form at the base of the Safin Dagh, in the Zagros Mountains of Iraqi Kurdistan, mentioned by Reed (1957). Habitats utilized embraced both still water (cut-off stretches of rivers and small lakes) and sluggish rivers. Anderson (1963) records the species from streams and lakes in southern Persia. It appears likely that the Caspian terrapin is found throughout the complex of small, sluggish rivers in Kurdistan, its distribution east of this area being limited by the lack of permanent water. The usual size of specimens caught was about 20 cms. carapace length; rather few juveniles were seen. The largest turtle caught was a male from two miles south-west of Deh-i-Shami; the shell was 23.5 cms. long. Feeding habits in the wild were not observed, except that one juvenile was seen eating the leg of a dead turtle of the same species. Captive specimens fed readily on any kind of meat offered, as well as on mealworms, which they would take from the hand. There seems to be no difference in average size between the sexes. The males can be distinguished by the usual characteristics of the more distally located vent and slightly concave plastron; sexing is easy even in specimens of about 8 cms. carapace length (the smallest caught). One male specimen, 20 cms. long, had a unilateral cleft on the left side of the upper jaw.

Localities: vicinity of villages of Sah Tang, Deh-i-Shami and Taut-Shami, some six miles north of main Baghdad-Tehran road, near Karind, Persia; vicinity of Sheikhabad, one mile north of main road, ca. 30 miles east of Kermanshah; Ab-i-Marik River, near Nam-i-Wan, 20 miles north by west of Kermanshah (all localities within previously known range).

Mauremys caspica rivulata. Recorded range: southern Yugoslavia, Albania, Greece, Crete, Aegean Islands (Corfu, Milos, Kythnos, Chios, Kos, Salonika), southern Bulgaria, Turkey, Syria, Israel and Cyprus.

Three adults (all ca. 19.5 cms.) and one juvenile were caught in a 15 ft. wide roadside irrigation ditch 10 miles north of Reyhanli, Southern Turkey; several other adults were seen but not caught. They differed from *Mauremys c. caspica* in the following details: plastron uniformly black, bridge almost entirely black, head dark brown on top, and with a dark brown streak passing from eye to tympanum; remainder of head pale brown with pale linear markings; head coloration of juvenile similar to that of *Mauremys c. caspica.*

Trionyx sp. A fragment of the carapace of a small soft-shell, comprising six neurals, seven pleurals, the associated vertebrae and ribs and a piece of dried leathery skin, of a size corresponding to a total length of about 15 cms., was found on the shore of the Gulf of Iskenderun, 5 miles south of Iskenderun, Turkey. It is impossible to decide whether this specimen should be assigned to *T. triunguis* or *T. euphraticus*, but, if the former, it could have been washed up from the Nile. Flower (1933) mentions the possibility of living softshells being washed into the Mediterranean by the Nile in flood, and landing on the coast of Israel; this being the case, it is possible that a dead specimen might be washed ashore further north, to Iskenderun. The shell of a small *Testudo graeca* (length 15 cms.) and a fragment of carapace of a

Mauremys caspica, both typical Turkish species, were found nearby, which may suggest that the soft-shell was of Turkish origin (i.e. *Trionyx euphraticus*).

Emys orbicularis. Known range: North Africa, Spain, Central France, Southern Germany, Poland, south to Italy, and west through Turkey to Persia. In Persia it is limited to the vicinity of the Caspian Sea and is not found in the arid regions further south (Blanford 1876, Anderson 1963). In coloration the species varies from almost uniform dull black in the northern parts of its range to an attractive pattern of yellow radiations or spots in the Middle East and southern Europe. The species appears to be abundant in the vicinity of Astara, on the Caspian coast on the border of Persia and Azerbaijan; several specimens were seen basking beside small bodies of still water beside the road. Pressure of time precluded systematic collecting, but two specimens were picked up off the road—an old male with carapace of length 11.6 cms. and a female of length 12.4 cms., apparently six years old judging by the well-marked growth rings. Both were brightly marked with yellow, but the precise disposition of this colour was very different in the two turtles; the top of the head of the male was unmarked black, while the sides of the head were marked with a very fine yellow pattern. The head of the female was marked all over with rather large yellow spots. The shell in both specimens was strongly marked with a yellow radiating pattern, the yellow colour predominating especially in the male. The eyes of the male were red in colour while those of the female were yellowish—an interesting and apparently unrecorded local parallelism with *Terrapene carolina.* It was unfortunate that more specimens could not be caught to see if this was constant throughout the population.

Two good-sized specimens of *Emys orbicularis*, the larger measuring 15 cms. in length, were caught in the same irrigation ditch in southern Turkey in which the *Mauremys caspica rivulata* were found; they shared the bright coloration of the Persian specimens mentioned above, but had yellow spots instead of radiating lines on the carapace.

Testudo graeca. This species is widespread in North Africa, south-east and south-west Europe and the Middle East. It is well-known that specimens from the Middle East are on the whole larger and darker than those from North Africa, and it is customary to consider the two populations as separate races (*T. g. ibera* and *T. g. graeca*) although Flower (1945) points out that individuals from Africa can reach a length of at least 275 mm. after long periods in captivity. The record for the species appears to be 305 mm. for a specimen from Iglitza, on the Danube (Boulenger 1902). I can find no significant difference in coloration between the shells of two juveniles collected by me in west-central Persia and two live specimens of much the same size from North Africa (precise locality unknown). However, the *T. graeca* collected by me in Persia are consistently larger than the large numbers of Moroccan *T. graeca* that are shipped to Britain for sale in pet shops; the latter average about 13 cms. in carapace length, while almost all the specimens from western Persia were more than 20 cms. long, and the largest, a female, was 25 cms. in length. In Algeria *T. graeca* is abundant in the low areas and scarce in mountainous country (Loveridge and Williams 1957); all the Persian localities were at an altitude of more than 5,000 ft., and the species appears to be scarce here also (only 17 live specimens were found in 2½ months' survey work, which entailed the coverage of perhaps 8 miles a day, over ground with very little cover for tortoises).

A number of broken shells was found in the vicinity of the villages, but the suggestion that the animals were used for food was vehemently denied by the natives.

Mating behaviour was witnessed on two occasions; one pair was seen near Sheikhabad (male 20.6 cms., female 21.8 cms.) on August 23rd, at 11.30 a.m.; they were situated in a dense growth of saplings on the edge of a small lake. The male followed behind the female, butting her from behind by thrusting the shell forward with head retracted, then mounting, with neck fully extended, mouth open, uttering high-pitched piping sounds. The female kept walking away and shaking her head vigorously from side to side; the male followed and repeated butting and mounting. This agrees in essentials with the account of Watson (1962), though this author does not mention the head shaking of the female. On the second occasion, twelve miles east of Mushkabad, the male followed the female closely, and butted her whenever she stopped; twice during the 15-minute observation period he walked right round the female and occasionally bit her hind leg. (Guibé (1950) also recorded biting occurring during the mating of this species.) The male mounted the female twice, tilting his shell to about 50 degrees to the horizontal, and remaining motionless in that position for about one minute, with mouth wide open, but making no sound. Carapace lengths were: male 23.8 cms.; female 25 cms. The time was 4 p.m. on September 10th.

An egg and fragments of others were taken from the body of a dead, badly decomposed tortoise 23 cms. long found in a dried-up stream near Deh-i-Shami, near Karind, Persia. This egg was unusually large, measuring 45 × 35 mm.; according to Gadow (1901) the eggs vary with the size of the female, but "those of a large *T. ibera* measure 32 to 36 × 30 mm." Other measurements for eggs (for North African *T. graeca*) are: 32 × 28 mm.; 33 × 24 mm.; 31.5 to 38.5 × 24.5 to 31 mm.; 37 × 26 mm. (Loveridge and Williams 1957); for Asiatic *T. graeca*: 34—42.5 × 27.6—35 mm. (Nikolsky 1915).

Localities: 26 miles west of Kermanshah, Persia, 8 miles from Shahabad; vicinity of villages of Sah Tang, Deh-i-Shami and Taut-Shami, some six miles north of main Baghdad-Tehran road, near Karind, Persia; vicinity of Sheikhabad, one mile north of main road, ca. 30 miles east of Kermanshah; 12 miles east by south of Mushkabad, which is 17 miles ENE of Arak, Persia.

Testudo graeca zarudnyi. This eastern Persian form was described as a full species by Nikolsky (1876), but was relegated to subspecific rank by Mertens (1946) and is considered as such by Wermuth and Mertens (1961) and Obst and Meusel (1963). It is said to be distinguished from *ibera* by the elongate carapace, with a feebly serrated hind margin, and the overall dark colour of the shell, with only indistinct markings. I have examined one of the paratypes and consider the form doubtfully recognisable at best, in view of the considerable variability of *Testudo graeca.* However, assuming the race to be valid, it is probable that six tortoises found apparently aestivating under rocky ledges beside a stream 15 miles east of Moorcheh Khort, which is 33 miles north of Isfahan, could be referred to *T. graeca zarudnyi:* certainly the shell is much darker than those of Turkish specimens, and somewhat darker than those from western Persia. The tortoises were within a few feet of each other in the aestivation site; the region was very arid, the only available water being the above-mentioned stream, which was rendered virtually undrinkable by a high concentration of magnesium sulphate. The largest of these tortoises had a 25.7 cm. carapace, while four of the others were almost as big. One of the males was observed copulating with two females within a period of half an hour, when the tortoises were confined on a tarmac yard within a week of capture.

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OBSERVATIONS ON THE MACRONYSSID MITE (ORDER ACARINA), *OPHIONYSSUS NATRICIS* (GERVAIS), ON THE TWO IGUANID LIZARDS, *UTA STANSBURIANA HESPERIS* AND *SCELOPORUS OCCIDENTALIS OCCIDENTALIS*

By

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INTRODUCTION

The most pernicious pest of reptile collections is the snake mite, *Ophionyssus natricis* (Gervais), a member of the Order Acarina, Family Macronyssidae. Feeding in excessive numbers, these mites cause great discomfort to their host, often resulting in its death by exsanguination. The snake mite is the vector of several deadly diseases afflicting reptiles and is important from this standpoint alone.

In the 1930's it was held that there were three snake mites, *Ophionyssus serpentium* and *Liponyssus triangulum* from North America, and *O. natricis* from Europe, and two lizard mites, *L. arabicus* from the Old World, and *O. easti* from North America. Captive snakes in the United States found to be harbouring *O. natricis* were thought to have encountered this mite from exposure to infested snakes imported from the Old World, as noted by Schroeder (1934). It was likewise thought that wild North American snakes infested by *O. natricis* had acquired these mites through exposure to released exotics or captives so infested.

Camin (1949) made a thorough study of the original types and collected many specimens of the above mites. He reduced *Ophionyssus serpentium*, *O. natricis*, *O. easti*, *Liponyssus triangulum*, and *L. arabicus* to synonomy with *Ophionyssus natricis*. Schroeder (1934) noted this mite caused lesions and much irritation to its host and transmitted necrotic stomatitis ("mouth rot"), and possibly bacterial enteritis. Camin (1948) showed *O. natricis* to be the vector of *Proteus hydrophilus*, a Gram negative rod and the bacterial etiological agent of a hemorrhagic septicemia in snakes. Kulp and Borden (1942) had already shown this bacterium was the cause of "red leg" in frogs.

Schroeder (1934) and Camin (1953) have shown that *Ophionyssus natricis* is a facultative parasite on snakes. It can freelive over an indefinite period of time and has been known to temporarily parasitize man and birds. The females leave the reptilian host to lay their 30 or more eggs singly in finely divided soil that is moist and rich in humus. These hatch in seventy-two hours.

The present problem consists of the effect of *Ophionyssus natricis* on two species of iguanid "sceloporine" lizards, the western side-blotched uta, *Uta stansburiana hesperis*, and the western fence swift, *Sceloporus occidentalis occidentalis*. The utas are covered by relatively small, granular, weakly imbricate scales, while those of a fence swift are larger and strongly imbricate. While wild populations were also studied, most investigation was channelled to the effects of this mite on captives of these two lizard species. Techniques for more effective mite control were also examined.

MATERIALS AND METHODS

Fifty (50) utas and one hundred and twenty-five (125) fence swifts were collected by "chase and grab" or pitfall traps for the study of captives. Wild lizards of both species were checked for mites at Alvarado Canyon, and Pacific Beach Bluffs, San Diego County, California. Mites were removed from the host by using a cotton swab dipped in 70% alcohol. When the swab was lightly applied to the mites they released their hold and were then removed by tweezers and placed in preservative (70% alcohol). Mites were also removed by Dri-Die 67 pans which were placed in the lizard cages. The lizards lie in the pan, allowing the Dri-Die 67 therein to kill the mites on them. The dead mites can be picked out of the powder with tweezers, and identified by means of a microscope and the keys in Camin (1949).

Live mites were observed on their living hosts with a binocular dissecting microscope and gross examinations of the reactions of the lizards to the mites were also noted.

RESULTS

Wild utas were never seen to be infested by mites, though mites were occasionally seen walking on captive specimens (Tables 1, 3 and 4). No mites were seen attached along the gular fold of the uta which would appear a likely site of infestation. Perhaps the uta habit of burrowing in fine soil deters the mite by mechanical abrasion—one of the effects of Dri-Die 67. However, the nature of the scalation of utas is probably the most significant deterrent to the mite. Additionally, utas were frequently observed in the wild and captivity picking mites off of the back of other utas.* Utas contracting and/or dying of a possibly mite-borne disease were afflicted in cages containing only utas. However, the disease (bacterial enteritis) is probably also transmitted by drinking contaminated water.

Captive swifts were heavily infested with mites, though those in cages with utas were considerably less so (Tables 1, 2 and 3). In mixed cages utas were occasionally seen to remove mites from the swifts. Numbers of swifts contracting and/or dying from mite-borne diseases were highest in cages not containing utas. The incidence of swifts infected with mite-borne disease was higher than that found for utas.

DISCUSSION AND CONCLUSIONS

Utas were definitely freer of mites than were the swifts. The largest number seen on any one uta at one time was five. In mixed cages utas appeared to reduce the incidence of mite infestation on the other lizards by preying upon the mites. The action of utas in removing mites from each other appears of value in ridding themselves of ectoparasites, as does their habit of burrowing in fine, dry soil. Such behaviour is largely, but not restricted to, the activity of young or hatchlings. Wild, adult utas, by tolerating young within their well-defined territories, incur the useful ectoparasite removing service of their offspring. A heavy infestation in wild reptiles is seldom reported, probably because the heavily infested reptile is so weakened as to be a ready prey to predators.

Mites often can be removed from reptiles by submergence for twelve to twenty-four hours in a container filled with lukewarm water. The reptile should be submerged so that only the tip of its nose is above the water line. Surviving mites are then removed from the nose with a towel. This method is impractical for utas and in the case of boas (*Constrictor constrictor*, Family Boidae) sometimes results in the mites invading and blocking the nasal passages. "Imperial" brand dog and cat flea killer is effective in killing mites on large snakes and lizards (e.g., *Tupinambis*, Family Teiidae), but water must be removed from the cage prior to dusting as this insecticide is toxic in water to reptiles. The author has found that a cage substrate of ocean bottom sand kills the mites' eggs, probably owing to the high salt content, thus breaking the cycle. Such sand should be removed during the egg-laying season of the reptiles, however, as the salt content is also lethal to reptile eggs. Ocean sand should also be replenished as the salt content appears to leach out with the passage of time.

Tarshis and Penner (1960) have shown that the non-toxic silica aerogel Dri-Die 67 (a very porous, finely divided amorphous powder, with an average particle size of 3 micra) is the best acaricide. This powder destroys arthropods by mechanically eroding away their cuticle, causing death by desiccation within a few hours. Submerging the reptilian host in the powder causes it no ill-effects. While broadcast application to the cage during mite infestations is the recommended technic, I have found the placing in the cage of a container filled with Dri-Die 67 one (1) inch deep is a less messy means of eliminating mites and preventing reinfestations. The size of the pan should be such as to accommodate several reptiles at one time. The Dri-Die has high warming capabilities and is a favored substrate of the lizards. By burrowing in the powder within the pan, the lizards eliminate and prevent reinfestation of mites, and Dri-Die need not be applied wholesale, giving a cage a "snowfall effect". Dri-Die, not being a poison, seems to prevent arthropods from developing any resistance to it. The container of Dri-Die should be removed and replenished when it becomes contaminated with sand or other cage detritus, or such contaminants screened out.

The application in the drinking water of water soluble aureomycin (3 grams in 3.79 litres of sterile, distilled water) prevents most mite-borne diseases. Many zoos give this solution daily. However, this procedure may enable bacteria to develop resistance to it. I have found daily application of aureomycin to sick reptiles is an effective cure, but its application once or twice a month is more effective for prevention.

It would be interesting to pursue this problem and see whether *Sceloporus* and *Uta* have similar endoparasites. *Uta* and *Sceloporus* are closely related, the former having diverged from the latter. The evolution of their endo-and ectoparasites would be an intriguing study in itself, especially if one considers the genera *Petrosaurus*, and *Urosaurus*, which are sometimes treated as separate or included within *Uta*. (As this is sent to press, a nematode worm 15 mm. long was removed June 18, 1965, from the intestine of a female *Uta stansburiana hesperis* with a snout-vent length of 37 mm. The worm was given to Dr. Andrew C. Olson, Parasitologist, San Diego State College for identification.)

SUMMARY

1. *Sceloporus occidentalis occidentalis* is more heavily infested by *Ophionyssus natricis* than *Uta stansburiana hesperis*. This appears partly due to *Sceloporus* having larger, strongly imbricate scales, allowing the mites an easier hiding place. *Uta* has much smaller, and less imbricate, granular scales, denying the mites a secure hiding place.
2. *Uta* tend to pick mites off each other which they see crawling around on a lizard, thus further lessening the incidence or extent of mite infestation.
3. In mixed cages, the *Uta* actively removed mites from the *Sceloporus*, also reducing the mite infestation of these lizards.
4. *Sceloporus* suffers more from mite-borne diseases, but especially so in segregated cages than in those containing *Uta*.
5. Placing of a container with Dri-Die 67 powder one inch deep allows lizards a means of ridding themselves of mites and preventing reinfestation.

6. Water soluble aureomycin administered daily in the drinking water cures lizards suffering from mite-borne diseases, but its application monthly is the best preventive.

Table 1. *Uta* alone (25 specimens)

Number of utas with mites	Number contracting and/or dying of mite-borne diseases
5	2

Table 2. *Sceloporus* alone (125 specimens)

Number mite infested	Heavy 50 mites	Medium 25 mites	Light 10 mites	Number contracting and/or dying of mite-borne diseases
86	56	20	10	10

Table 3. *Uta* (25) and *Sceloporus* (25) mixed = 50

Lizard	Number mite infested	Heavy 50 mites	Medium 25 mites	Light 10 mites	Number contracting and/or dying of mite-borne diseases
Uta	0	0	0	5	0
Sceloporus	10	2	3	5	1

Table 4. Wild *Uta* (50), *Sceloporus* (50)

Lizard	Number mite infested	Heavy 50 mites	Medium 25 mites	Light 10 mites	Number with mite-borne diseases
Uta	0	0	0	0	0
Sceloporus	10	5	3	2	0

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* Mite removal by utas is by one of two ways: (1) If the mite is moving, the utas remove them by means of their proportionately large (for the lizard), slightly protrusible, fleshy tongue. The mite adheres to the moist tongue, which is then drawn back into the mouth of the uta. (2) If the mite is attached, the uta uses its jaws to remove the arthropod, the removing lizard biting as close to the body of the infested individual as possible and pulling the mite off with a strong bite. Mastication of the mite may or may not follow either removal procedure.

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THE SIZE OF A SERIES OF LEICESTERSHIRE NEWTS

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INTRODUCTION

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Although our knowledge of the British amphibians is extensive, some aspects seem to have been ignored and there are few accurate and reasonably detailed accounts of size in the literature. This paper presents a series of accurate measurements under four headings:

(a) Absolute size—averages, extremes and distribution,
(b) Physical proportions—length of body related to length of tail,
(c) The relative size of the three Leicestershire newts.
(d) Exceptional newt populations.

EARLIER WORK

The only other work on Leicestershire newts was the qualitative survey of Squires (1964). Higginbottom (1853) gives measurements for various life-stages of the Crested Newt (*Triturus c. cristatus*), the most important of which are: size at metamorphosis 43-62 mm. and size at maturity 87-118 mm. Smith (1954) gives corresponding measurements for the Smooth Newt (*Triturus v. vulgaris*) of 35 mm. and 58-70 mm. respectively, and states that the Palmate Newt (*T. helveticus*) measures 28-35 mm. at metamorphosis. Boulenger (1894) gives maximum lengths for *T.c. cristatus* as ♂ 144 mm. and ♀ 162 mm.; for *T.v. vulgaris* as ♂ 104 mm. and ♀ 94 mm. and for *T. helveticus* as ♂ 80 mm. and ♀ 85 mm. For Scotland, Evans (1894) gives the maxima as: *T.c. cristatus* ♂ 145 mm., ♀ 156 mm., *T.v. vulgaris* ♂ 97 mm., ♀ 97 mm.; *T. helveticus* ♂ 83 mm. (av. 75.2 mm.), ♀ 88 mm. (av. 79.7 mm.).

For the New Forest, Creed (1964) gives metamorphosis lengths as 55 mm. for *T.c. cristatus* and 25-35 mm. for *T.v. vulgaris* and *T. helveticus*. Evans (1894) provides a short series of weights: *T.c. cristatus* ♂ 10.6, 8.4 and 7.6 gm.; ♀ 9.4, 8.7 and 6.3 gm.: *T.v. vulgaris* ♂ 2.1, 2.1 and 1.7 gm.; ♀ 3.5, 2.7 and 2.3 gm.: *T. helveticus* ♂ 1.5-2.1 gm.; ♀ 2.1-2.4 gm. Creed (1964) considered that in adult newts body length (i.e. to posterior margin of the cloaca) exceeds tail length; Smith (1954) thought that the opposite is true.

METHODS

Virtually all newts were caught by netting—some by more or less random sweeps, others as they surfaced to breathe. A net with a six-foot ash handle, fourteen-inch frame and a coarse mesh proved successful.

Measurement of length was by a transparent plastic ruler graduated in millimetres. Three persons were needed, to hold the newt, the ruler and to record the data respectively. Newts were weighed in a plastic bag on a spring-balance to an accuracy of 0.5 gm. (weights accurate to 0.01 gm. are at present being recorded in Rutland by E. P. Killips).

The chi-square test is used with two contingency tables.

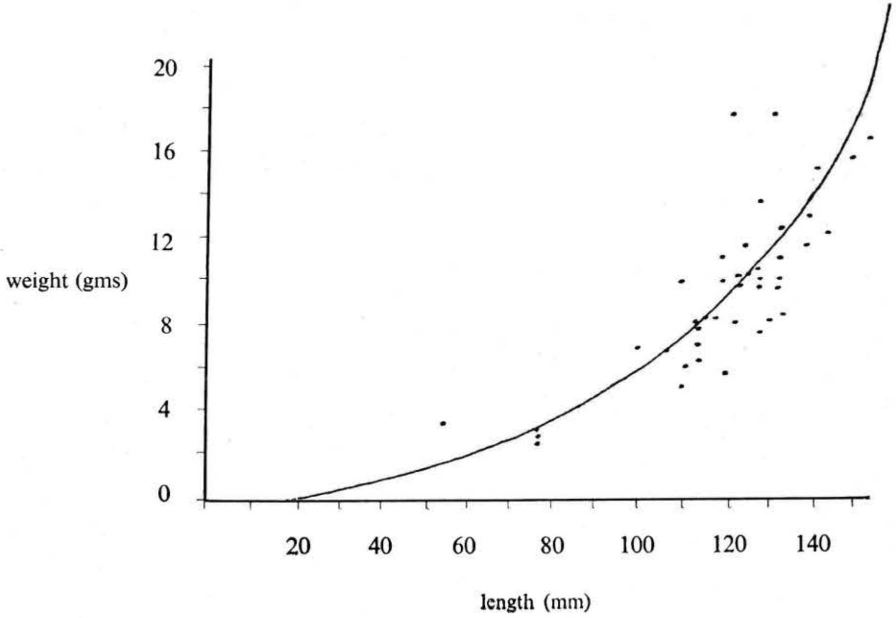
RESULTS

Absolute Size: Table 1. Average and extreme sizes in both sexes of the three British species. Graph 1 expresses weight increase with length in *T.c. cristatus*. The histograms show the dstribution of arbitrarily defined classes in *T.v. vulgaris*.

Physical Proportion: Table 2 shows the relationship of head + body (h and b) to the length of tail (t) in both sexes of the three species. Of the 18 measurements for *T.v. vulgaris* for which h and b $<$ t, 13 were made in one catch of 29 individuals.

Relative Size: Table 3 shows the relative size, expressed as total length, of *T.v.vulgaris* and *T. helveticus*. The value of 75 mm. was chosen as the dividing line because it was the nearest convenient figure to the average lengths of the two species; individuals measuring exactly 75 mm. were disregarded.

Exceptional Populations: Table 4 gives the measurements of two Leicestershire newt populations known to deviate from the average in size.



Graph: Increase of weight with length in *Triturus c. cristatus*

DISCUSSION

In Table 1 it is of interest to compare my results with those of earlier workers. One point which does emerge is that there is an overlap between the three species, so that accurate specific identification by size alone is impossible. In general, in British newts *T.c. cristatus* is so much the largest that significance tests are unnecessary, but the relationship between *T.v. vulgaris* and *T. helveticus* is more subtle. The probability that the size distribution amongst the males of the two species is due to chance is so remote that the null hypothesis—in this case that there is no significant difference in size between males of the two species—can be confidently rejected (Table 3). By inspection, *T.v. vulgaris* can be seen to be the larger, but when the females are similarly examined, the probability of the size distribution being due to chance is so great that the null hypothesis cannot be rejected (if anything, there is a weakly defined tendency for *T. helveticus* to be the larger). Thus, the oft-repeated statement that the Smooth Newt is larger than the Palmate Newt is not applicable to females, though true of males.

As to physical proportion, there is a well marked tendency for the length of head+body to exceed the length of the tail (Table 2). This is especially noticeable in and always true for *T.c. cristatus*. The length of the caudal filament in males of *T. helveticus* was found to vary from 2 to 7 mm. independently of the total length of the newt; the filament is sometimes present in the females, but was never observed to exceed 1 mm. Perhaps the length of some physical feature—such as the hind limb—may prove to be a reliable index to total length.

Newt populations exist in which specimens differ significantly in size from the average (Table 4).

The aberrant Smooth Newt population is a dwarf one breeding in an artificial reed-swamp in the city of Leicester at SK587067. The water nowhere exceeds a foot in depth, though formerly it was much deeper. It supports a quite dense population of invertebrates (notably *Acilius*, *Asellus*, *Notonecta* and *Planorbis*) and a resident colony of frogs (*Rana t. temporaria*). Above the swamp (now in the process of being filled in) is an area of rough grassland on which many immature newts have been found. Some almost incredibly small newts have been found here, the smallest males 46, 55 and 60 mm. long respectively, and the smallest females 52, 53, 54, 55, 57, 59 (2) and 60 mm. long respectively. The smallest mature length reported by Smith (1954) is 58 mm. Very small mature newts are distinguished from subadults by the fact that they coexist in water with breeding newts, the degree of development of the cloaca, the increase in size of the dark ventral markings, and, in the case of the males, the development of the crest.

In contrast the Crested Newt population at Braunstone, especially the females, is tending towards gigantism. The pond here is small but deep and is also being filled in. It supports a small invertebrate population but a large newt population of both *T.c. cristatus* and *T.v. vulgaris* (the latter are quite normal in size). Three of the four largest Crested Newts recorded from the county—157, 146 and 142 mm.—have come from here.

From the Leicestershire figures it seems that *T.c. cristatus* metamorphoses at 50-60 mm. in total length and *T.v. vulgaris* and *T. helveticus* at 25-30 mm. Maturity in *T.c. cristatus* seems to be reached at about 100-110 mm. in *T.v. vulgaris* at about 65-75 mm. and in *T. helveticus* at about 60-75 mm. In all three species, maximum larval development is attained shortly before metamorphosis (but see Creed, 1964, who states that it is reached at metamorphosis).

The histograms show obvious differences in size between the sexes in adult *T.v. vulgaris* but the similarities that they reveal are more striking. Both reach maximum value in the same groups (76-80 mm. and 3.1-3.5 gm.), both are biased in favour of smaller values, and they reach almost identical origins and end-points. The curves for the males, however, appear to be more normal than those for the females, which are rather flattened.

Some immature newts live in water, and certainly many adults, especially those of *T.c. cristatus* and *T. helveticus* stay in water the whole year round.

The only neotenic specimen examined (a Smooth Newt) did not differ significantly in size from normal adult measurements.

SUMMARY

1. A series of the three Leicestershire newts, i.e. *Triturus v. vulgaris*, *T. helveticus* and *T.c. cristatus* was investigated quantitatively.
2. *T.c. cristatus* is the largest of the three. The males of *Triturus v. vulgaris* and *T. helveticus* differ significantly in size, the females do not.
3. In most adult newts, the length of head+body inclusive exceeds the length of the tail.
4. Exceptional populations exist in which newts differ markedly in size from the average.

species	sex	total length (mm.) av.	max.	min.	n	total weight (gm.) av.	max.	min.	n
Triturus v. vulgaris	♂	78.9	100	46	155	3.3	5.0	1.5	81
	♀	75.9	98	52	131	3.4	5.5	1.5	64
Triturus helveticus	♂	69.3	83	58	48	2.2	3.5	1.0	15
	♀	76.1	90	65	43	3.7	5.5	2.0	16
Triturus c. cristatus	♂	119.6	140	100	17	8.9	17.5	4.5	20
	♀	128.0	157	111	28	10.7	17.5	4.0	23

Table 1: Absolute Size
n = number of measurements (= 641)

species	sex	h+b>t actual no.	h+b>t approx. %	h+b<t actual no.	h+b<t approx. %	h+b=t actual no.	h+b=t approx. %	n
Triturus v. vulgaris	♂	23	45	18	35	10	20	51
	♀	44	96	0	0	2	4	46
Triturus helveticus	♂	36	90	1	2.5	3	7.5	40
	♀	37	98	1	2	0	0	38
Triturus c. cristatus	♂	11	100	0	0	0	0	11
	♀	13	100	0	0	0	0	13
totals and averages		164	82	20	10	15	8	199

Table 2: Physical Proportions of *Triturus*

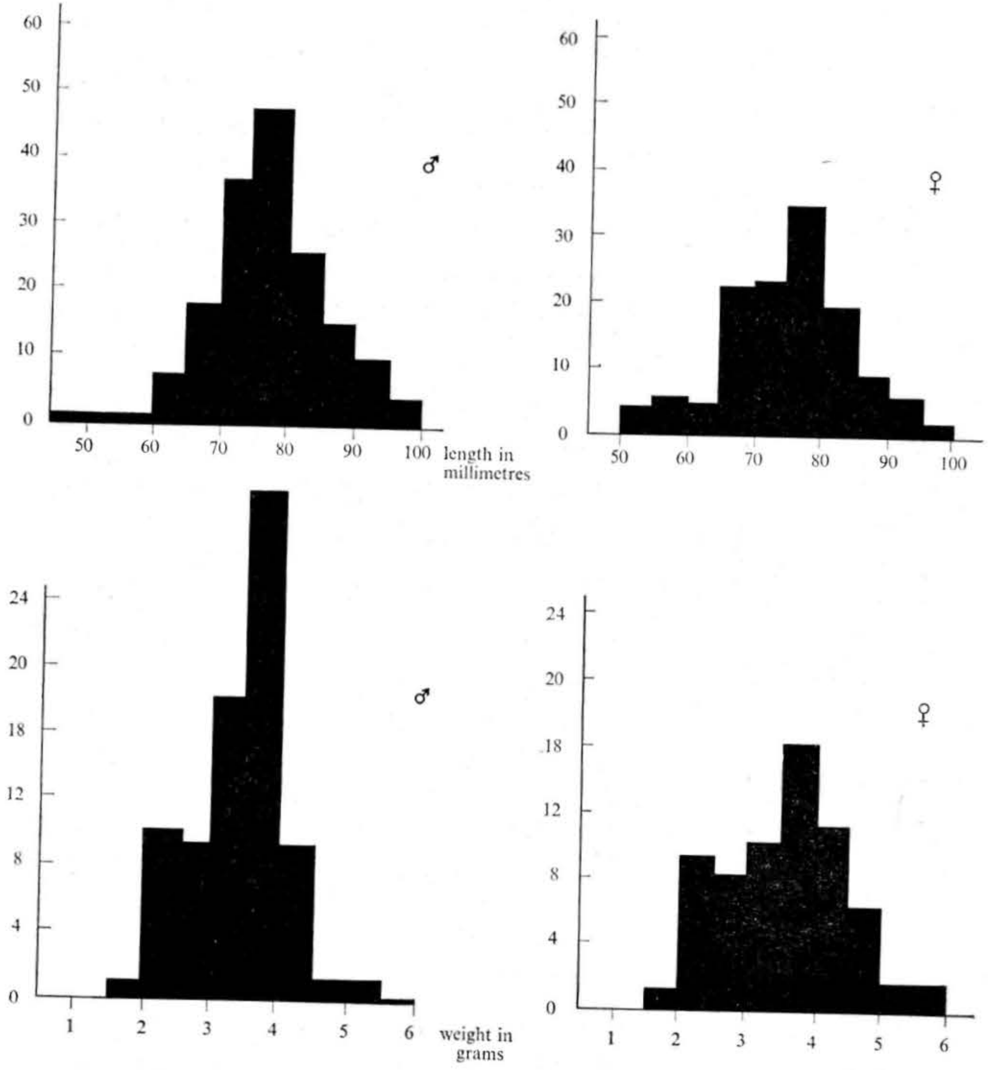
MALE

species	TL >75 mm.	TL <75 mm.	T
T. vulgaris	94 (86.56)	35 (42.44)	129
T. helveticus	10 (17.44)	16 (8.56)	26
T	104	51	155
	$\chi^2 = 11.58$	$P < 0.001$	

FEMALE

species	TL >75 mm.	TL <75 mm.	T
T. vulgaris	74 (76.6)	42 (39.4)	116
T. helveticus	29 (26.4)	11 (13.6)	40
T	103	53	156
	$\chi^2 = 1.01$	$P > 0.30$	

Table 3: Relative Size of *Triturus v. vulgaris* and *T. helveticus*
TL = total length
T = total
expected (random) distribution bracketed.



Histrograms: Size-Distribution in *Triturus v. vulgaris*

Vertical column shows number of newts in each class.

Horizontal column shows the upper limit of each class.

species	place	sex	total length (mm.)						total weight (gm.)					
			av.		range				av.		range			
					max.		min.				max.		min.	
			L	P	L	P	L	P	L	P	L	P	L	P
T.v. vulgaris	Leicester SK587067	♂	79	69	100	80	46	46	not known					
		♀	76	61	98	74	52	52						
T.c. cristatus	Braunstone SK555028	♀	128	135	157	157	111	119	10.7	11	17.5	16.5	4	8.5

Table 4: Two Exceptional Newt Populations

L = Leicestershire values

P = values for stated locality

ACKNOWLEDGMENTS

Most of the measurments were made by myself and D. A. Roff in 1964 or with N. R. Dove in 1965. Other members of the Leicestershire Herpetological Study Group have given valuable assistance, especially R. D. Osborne and E. P. Killips. I am grateful to Professor H. P. Moon, for invaluable criticism and advice, and to I. M. Evans, Curator of Biology at the Leicester Museum, for his continual encouragement.

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BICEPHALISM IN THREE COLUBRIDS

By

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(*Received* 6/11/65)

A juvenile bicephalic *Tropidoclonion lineatum lineatum* (total length 109 mm. and tail length 20 mm.) collected by Robert Schreiner in Kansas City, Missouri, July 23, 1965, was brought to Max Allen's Zoological Gardens, Eldon, Missouri, August 20, 1965. This snake died on September 9, 1965. A variety of food items known to be eaten by this species was offered but the snake refused to feed. Both tongues were functional, although the tongue of the right head protruded five times as often. The right head also appeared to direct locomotion. This specimen is No. 65-039 in the collection of Max Allen's Zoological Gardens.

A juvenile bicephalic *Thamnophis sirtalis concinnus* (total length 130 mm. and tail length 32 mm.) was collected near Gearheart, Clatsop County, Oregon, May 25, 1955. The snake died on June 1, 1955 and is deposited in the Arizona State University collection, ASU 2774.

A hatchling bicephalic *Heterodon platyrhinos* (total length approximately 220 mm.) was collected in Brazil, Appanoose County, Iowa, in late September, 1960, by P. G. Seals. I did not see this specimen but a picture of it published in the Iowegian (local newspaper) October 2, 1960, was identifiable as the above species. The snake utilized both heads in feeding and drinking. Both necks were capable of flattening in the typical manner. This specimen died in mid-November, 1960, and is preserved and retained by P. B. Seals, Mystic, Iowa (personal communication).

RESORT TO WATER OUTSIDE THE BREEDING SEASON OF THE CRESTED NEWT *Triturus c. cristatus* (Laurenti)

By

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(*Received* 29/11/65)

Most literature on the British newts represents the adults as resorting to water during spring and early summer, and remaining on land for the rest of the year. For the Crested Newt, the aquatic period is generally given as roughly from March to July. However, Duerigen (1897) mentions that newts of the genus *Triturus* may sometimes stay in water all the year round, Frommhold (1959) gives the aquatic period for *T.c. cristatus* in Central Europe as approximately from February to late summer, and Malcolm Smith (1951) says that this species "in some ponds in different parts of England can be found in the water all the year round".

Observation over some ten years of newts introduced into a garden pond in Hertfordshire shows that the three British species leave the water by the end of July at the latest, but invariably a few *T. cristatus* return to the water in October or November and remain there throughout the winter. Males which do this take on the breeding coloration shortly after entering the water, the white stripe on the tail in particular becoming prominent, and partly develop the dorsal crest, which remains in this part-grown stage until spring and then completes its development.

No particular conclusions were drawn from this, as the area around the pond is enclosed and this may have affected behaviour at the time of hibernation. During years of observation in the wild in several European countries, I had until recently never seen any of the three British species in water outside the period March to July, except for a few instances in exceptionally warm weather during the latter half of February. The Alpine Newt *T. alpestris* is different, being often found in the water outside the normal breeding season.

On the 28th September, 1965 I was examining some abandoned gravel workings near Whittlesey in Cambridgeshire. The excavations had formed a number of ponds, of which the older ones were thick with weeds and rushes, but the more recently formed ones were largely free of vegetation. The water in all of them was clear. In one of the recent ponds I saw an adult male Crested Newt swimming along the bottom. The tail stripe was prominent and the crest half-grown. A short search in a few of the other ponds with little vegetation produced seven more specimens—two males, four females and a half-grown juvenile. The adults were all in breeding coloration and the crests of the males were part-grown. Of this total of eight specimens, four (two males, one female and the juvenile) were in open water away from any cover, while the remaining one male and three females were hidden in patches of weed or under pieces of wood in the water.

The area of open water observed (to the extent that all specimens away from cover would be seen) was estimated at about 5% of the total water area in the excavations, and the area more closely examined (so that very probably all specimens present were disclosed) at only about 1%. If the density of newts in these areas was representative of the total water area (and it could well have been less since the more thickly weeded ponds were not examined), the total number of newts in all the ponds must have been around 300.

All logs, stones and debris on land within about 20 feet of the water's edge along the areas examined were overturned but only one specimen, a recently metamorphosed juvenile, was found. Only one larval Crested Newt was seen in the water, as well as one larval Smooth Newt *T. vulgaris*, no adults of this latter species being found.

Incidental observations were that all the adults were noticeably robust and appeared somewhat above average length for the species, and that in all the specimens caught and examined (being all those seen except the first one) the lighter parts of the undersides were an unusually dark vermilion. A further series of ponds in abandoned gravel workings some five miles away near Peterborough was examined the same day. No newts were found in the water, but one adult female *T. cristatus* was found under a log a few feet from one of the ponds. This specimen was of more normal size and girth, and the light colour of the undersides was pale yellow.

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A DISCOGRAPHY OF PALEARCTIC AMPHIBIAN SOUND RECORDINGS

By

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INTRODUCTION

The purpose of this paper is to bring together a list of sound recordings of Palearctic amphibia commercially available either on gramophone records or on so-called "tape-records". I can trace no discs from beyond Europe, though it is possible that some Japanese ones may have escaped me.

All of the recordings are of species (or races) of Anura. No less than fourteen of the twenty-two European species listed in Hellmich (1962, p. 155) appear on at least one disc or tape.

The references are listed below alphabetically by recordists' surnames. The number given to each is used in the subsequent index of species which is alphabetical by genera, species and sub-species.

A comparable discography of bird sound recordings has already been published (Boswall, 1964 and 1966); one on mammal sounds is completed and a third covering the class Insecta has been accepted by *Entomologist's Record*.

THE DISCOGRAPHY

1. ROCHE, JEAN-CLAUDE (1959): *Oiseaux en Camargue*.

One, 10 inch, 33.3 r.p.m. disc, no. LDP-B.250 Med. Pacific, 20 bis, rue Louis Philippe, Neuilly (Seine), France. Distributed in Britain by Rare Records Ltd., 5-7 Barton Square, Manchester.

Side 1 European Tree Frog (*Hyla arborea*); Natterjack Toad (*Bufo calamita*).

2. ROCHE, JEAN-CLAUDE (1960): *Oiseaux en Bretagne*.

One, 10-inch, 33.3 r.p.m. disc, no. LDP-B.260 Med. Pacific, 20 bis, rue Louis Philippe, Neuilly (Seine), France. Distributed in Britain by Rare Records Ltd., 5-7 Barton Square, Manchester.

Side 1 *Band* 2 Edible Frog (*Rana esculenta*); Midwife Toad (*Alytes obstetricans*).

3. ROCHE, JEAN-CLAUDE (1961): *Francis de la Nuit*.

One 7-inch, 33.3 r.p.m. disc, no. CLA 1009. Clartes, 6 rue des Capucines, Paris 2e.

Side 1 Natterjack Toad (*Bufo calamita*); Edible Frog (*Rana esculenta*).

Side 2 Midwife Toad (*Alytes obstetricans*); European Tree Frog (*Hyla arborea arborea*).

4. ROCHE, JEAN-CLAUDE (1961): *Les Voix de la Nuit*.

One, 7-inch, 45 r.p.m. disc. no. LVB 1. "La Vie des Bêtes", 49 Avenue Iéna, Paris 16e.

Side 1 European Tree Frog (*Hyla arborea arborea*); Midwife Toad (*Alytes obstetricans*).

5. ROCHE, JEAN-CLAUDE (1961): *Au Bord de la Rivière et de l'Etang*.

One, 7-inch, 45 r.p.m. disc, no. LVB 2. "La Vie des Bêtes", 49 Avenue Iéna, Paris 16e.

Side 2 Edible Frog (*Rana esculenta*); Natterjack Taad (*Bufo calamita*).

6. ROCHE, JEAN-CLAUDE (1962): *Paysages d'Oiseaux*.

One, 10-inch, 33.3 r.p.m. disc, no. LDP-B 2305. Pacific, 20 bis, rue Louis Philippe, Neuilly (Seine), France. Distributed in Britain by Rare Records Ltd., 5-7 Barton Square, Manchester.

Side 1 Natterjack Toad (*Bufo calamita*); Yellow-bellied Toad (*Bombina variegata*); Toad sp. (*Pelodytes punctatus*).

7. ROCHE, JEAN-CLAUDE (1965): *Guide Sonore du Naturaliste*: 2 *Batraciens*.

One, 7-inch, 45 r.p.m. disc. Obtainable from J.-C. Roché, La Malière, Collobrières (Var), France.

Side 1 Common Toad (*Bufo bufo*); Natterjack Toad (*Bufo calamita*); Green Toad (*Bufo viridis*); Yellow-bellied Toad (*Bombina variegata*); Midwife Toad (*Alytes obstetricans*).

Side 2 Toad Sp. (*Pelodytes punctatus*); Mediterranean Tree Frog (*Hyla arborea meridionalis*); European Tree Frog (*Hyla arborea arborea*); Edible Frog (*Rana esculenta*).

8. TRABER, HANS (1954): *Tierstimmen*.

One, 10-inch, 78 r.p.m. disc, no. 9. Obtainable from Hans Traber, Frohburgstrasse 46, Zurich 6, Switzerland.

Edible Frog (*Rana esculenta*); European Tree Frog (*Hyla arborea arborea*); Mediterranean Tree Frog (*Hyla arborea meridionalis*); Common Toad (*Bufo bufo*); Yellow-bellied Toad (*Bombina variegata*); Midwife Toad (*Alytes obstetricans*).

9. TRABER, HANS (1955): *So Singen Unsere Vogel.*

One, 10-inch 78 r.p.m. disc, no. 13. Obtainable from Hans Traber, Frohburgstrasse 46, Zurich 6, Switzerland.

Common Toad (*Bufo bufo*).

10. TRABER, HANS (1958): *So Singen Unsere Vogel.*

One, 7-inch 33.3 r.p.m. disc, no. 14. Obtainable from Hans Traber, Frohburgstrasse 46, Zurich 6, Switzerland.

Yellow-bellied Toad (*Bombina variegata*).

11. TRABER, HANS (1960): *Tierstimmen.*

One, 7-inch, 33.3 r.p.m. disc, no. 22. Obtainable from Hans Traber, Frohburgstrasse 46, Zurich 6, Switzerland.

Side 1 Edible Frog (*Rana esculenta*); European Tree Frog (*Hyla arborea arborea*); Mediterranean Tree Frog (*Hyla arborea meridionalis*); Common Toad (*Bufo bufo*); Yellow-bellied Toad (*Bombina variegata*); Midwife Toad (*Alytes obstetricans*).

12. VEPRINTZEV, BORIS (1959-63): *The Voices of Birds in Wild Nature.*

Two, 10-inch, 33.3 r.p.m. discs, nos. 6227-8, 7751-2. All Union Studio of Disc Recording, Mezhdunarodnaja Kniga, 32/34, Smolensk Square, Moscow, 200.

Disc 6228, *Band* 18 Marsh Frog (*Rana ridibunda*).

Disc 7751, *Band* 8/9 Marsh Frog (*Rana ridibunda*).

13. WEISMANN, CARL (1939): *Voice Recordings of Danish Birds.*

One, 12-inch, 78 r.p.m. disc, no. 1. Obtainable from C. Weismann, Strodam, Hillerod, Denmark.

Marsh Frog (*Rana ridibunda*).

14. WEISMANN, CARL (1947): *Voice Recordings of Scandinavian Amphibians.*

One, 10-inch, 78 r.p.m. disc, no. 5. Obtainable from Carl Weismann, Strodam, Hillerod, Denmark.

Fire-bellied Toad (*Bombina bombina*); European Tree Frog (*Hyla arborea arborea*); Edible Frog (*Rana esculenta*); Moor Frog (*Rana arvalis*); Common Frog (*Rana temporaria*); Agile Frog (*Rana dalmatina*); Spade-foot Toad (*Pelobates fuscus*); Common Toad (*Bufo bufo*); Natterjack Toad (*Bufo calamita*); Green Toad (*Bufo viridis*).

15. WEISMANN, CARL and LISE (1962): *Voice Recordings of Scandinavian Amphibians.*

Two, 4-inch diameter, 7½ i.p.s full track reels of tape, nos. 16 and 17. Obtainable from: C. Weismann, Strodam, Hillerod, Denmark.

Tape 16 Edible Frog (*Rana esculenta*); Marsh Frog (*Rana ridibunda*); Moor Frog (*Rana arvalis*); Common Frog (*Rana temporaria*); Agile Frog (*Rana dalmatina*).

Tape 17 Fire-bellied Toad (*Bombina bombina*); European Tree Frog (*Hyla arborea arborea*); Spade-foot Toad (*Pelobates fuscus*); Common Toad (*Bufo bufo*); Green Toad (*Bufo viridis*); Natterjack Toad (*Bufo calamita*).

CROSS-INDEX OF SPECIES

Alytes obstetricans Midwife Toad 2, 3, 4, 7, 8, 11.
Bombina bombina Fire-bellied Toad 14, 15.
Bombina variegata Yellow-bellied Toad 6, 7, 8, 10, 11.
Bufo bufo Common Toad 7, 8, 9, 11, 14, 15.
Bufo calamita Natterjack Toad 1, 3, 5, 6, 7, 14, 15.

Bufo viridis Green Toad 7, 14, 15.
Hyla arborea arborea European Tree Frog 1, 3, 4, 7, 8, 11, 14, 15.
Hyla arborea meridionalis Mediterranean Tree Frog 7, 8, 11.
Pelobates fuscus Spade-foot Toad 14, 15.
Pelodytes punctatus Toad sp. 6, 7.
Rana arvalis Moor Frog 14, 15.
Rana dalmatina Agile Frog 14, 15.
Rana esculenta Edible Frog 2, 3, 5, 7, 8, 11, 14, 15.
Rana ridibunda Marsh Frog 12, 13, 15.
Rana temporaria Common Frog 14, 15.

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COITAL BEHAVIOUR OF THE AFRICAN TORTOISE *KINIXYS EROSA*

BY

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(*Received* 12/7/65)

The genus *Kinixys* is restricted to Africa, (Ditmars, 1951. Rose, 1950). In Nigeria there are two species, each confined to a particular habitat. *K. erosa* is the forest species and has an elaborate shell structure. *K. belliana* is the savanna species and has a shell that conforms in general appearance to those of the European species of *Testudo*.

The following observations were made on a pair of animals which were housed in a large aviary, situated in the Biological Garden of the University of Ife, at Ibadan. The aviary was shared by a population of birds of several species, two species of squirrel, several fruit bats, a pair of *K. belliana* and three specimens of *K. erosa*.

The animals were first observed mating on the morning of April 9th. Later, however, it was learned that they had been observed to mate some five days previously, by a Nigerian Zoo Keeper who had failed to report it.

The male was observed to approach the female from the side and try to mount her. After several unsuccessful attempts he succeeded in climbing upon her from the tail end. The female at this time was lying with her plastron parallel to the ground and her tail extended beyond the edge of the shell, also parallel to the ground.

The male raised himself with his forelegs, pushing on the female's carapace so that his shell was at an angle of almost 90° to the ground. His tail being angled to his body and placed in a forward position between his fully extended hind legs, thus lying under and slightly to the left of the female's tail. At this stage the two cloacas touched and united. The male then lowered his forelegs so that he again rested on the female's shell. The female extended her hind legs so that her body was angled at, about 15° to the ground. The male then extended his neck fully in a downward curve towards the female's neck with his mouth open wide. The female responded by extending her neck upwards and backwards towards the male's open mouth. It seemed that at this stage the male would grasp the female's neck in his mouth; this did not occur, however.

At the moment when, presumably, orgasm occurred the male emitted a series of hissing squeaks. Soon after this the female began to walk in a circle, the male still united, being dragged along until he finally slid off her back. She then retreated into a corner and withdrew into her shell.

A young tortoise with a carapace size of 40mm. × 40mm. was seen in the aviary in late April, presumably the result of an earlier mating. This, perhaps, suggests that the eggs are laid singly rather than in batches.

The young tortoise was found decapitated some nine days later. This could have been done by an adult *K. erosa* for contrary to one writer (Cansdale, 1955) the diet of this species is not confined to vegetable material, and fresh meat and carrion are readily eaten.

After this paper was presented the writer has discovered another forest species of Kinixys occurring within Nigeria, Kinixys homeana. K. homeana is superficially similar to K. erosa but the carapace possesses a precentral shield. In K. erosa the anterior extremities of the plastron project beyond the carapace (when the animal is viewed dorsally or laterally). This is not so in K. homeana. The two species appear to occupy similar habitats.

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EGG-LAYING IN *LACERTA AGILIS*

According to Smith (*The British Amphibians and Reptiles*, 3rd. Edition, 1964), there is no record of the British Sand Lizard (*Lacerta agilis*) twice laying eggs in the same season. However, a female of this species, maintained in an outdoor reptiliary, has recently done so. The first batch of 10 eggs (though one of them was destroyed while being dug up) was laid in sand between 6 p.m. and 9 a.m. on June 14/15th, 1965. The date of the second laying is unknown. None of the eggs of the first batch had hatched by the 12th of September, and they were dug up on September 17th, in order to incubate them artificially. It was then that the second clutch was discovered in exactly the same place.

All nine eggs of the first clutch hatched between 17th and 23rd of September. The nine eggs of the second batch were all much smaller than were those of the first just before hatching. They had not hatched by October 10th, but had finally done so by October 29th. Judging by their external appearance eggs of the second batch had probably hatched at about October 23rd.

Since there is only one pair of Sand Lizards present in the reptiliary, and for most of the time eggs were kept in the damp at 76° F, the eggs, from one female only, thus show differences in size and hatching times which must strongly suggest that they were laid at different times.

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(*Received* 1/11/65)

THE WORLD OF REPTILES

By

Angus Bellairs and Richard Carrington

(*Chatto and Windus, London, pp.* 153)

In this delightful little book Chapter I introduces the subject by discussing general reptilian morphology. The following chapters 2-5 deal respectively with Tortoises and Turtles, Lizards and Tuatara, Snakes and then Crocodiles and their allies. Lastly scientific nomenclature is briefly discussed, the Class Reptilia is phylogenetically systematised and a bibliography of 41 references is listed, each with a brief note on its contents.

The subject matter is mainly concerned with the living specimens, and fossil ancestors are only occasionally mentioned. This treatment could have led to tedious descriptions of successive genera, but the authors have managed to provide a blend of interesting facts for both the naturalist, and the more serious zoologist. The result should satisfy all those readers who like to read about reptiles, and should whet the appetite of those who, for various reasons, wish to proceed further with the subject.

Among the pages we learn that: Reptiles cannot hear very well; they have tiny brains; a giant Indian Ocean tortoise lived for 152 years; among lizards is the Flying Dragon (Draco), which can glide through the air—one is tempted to say 'with the greatest of ease'—using wing-like extensions of flank skin; Geckos walk upside-down on the ceiling by means of scaly pads on their feet; probably 30 to 40,000 people in the world die of snake bites every year: snake-charmers probably exert their influence by movement, not sound; and the docile Indian python is the one used in strip-tease acts!

There are a number of nice photographs of various genera. The book is well produced and good value at 25/-. It would make a nice Xmas present for anyone who likes natural history.

H. Fox.

FROM OTHER JOURNALS:

Back issues of the East German journal 'Aquarien, Terrarien' contain the following papers of herpetological interest.

Olexa, A. & Kral, Üeber Fang, Transport und Haltung des Bandmolches, *Triturus vittatus*. (On the catching, transport and husbandry of *T.V.*) 1963; **10**; 43-48.

Petzold, H. G. Der Sechszehenfrosch, *Rana hexadactyla*. 1963. **10**; 58-60.

Koch, H. Haltung und Zucht von Tokehs, Gekko gecko. (Husbandry and Breeding of *G.g.*) 1964; **11**; 111-113.

Obst, F. J. Erfahrungen mit Riesenkröten. (Experiences with Giant Toads) 1964; **11**; 134/5.

Petzold, H. G. On Cobras 1964; **11**; 147-151.

Olexa, A. Blaue Anolis. (Blue Anolis) 1964; **11**; 183-185.

Kabisch, K. & Engelhard, H. Beobachtungen an Reptilien in der Umgebung von Varna-Goldsand. (Reptiles on the Black Sea coast). 1964; **11**; 194-197.

Petzold, H. G. Alfred Edmund Brehm—heute gesehen. (Biographical notes on A. E. Brehm). 1964; **11**; 202-206.

Petzold, H. G. Ueber Freileben und Terrarienhaltung der Taurischen Eidechse. (*Lacerta taurica* Pall. free and in captivity) 1965; **12**; 112-117.

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Reproduction and juvenile development of two pit vipers.

E. ELKAN

An International Meeting on

INTEGRATIVE MECHANISMS AND BEHAVIOUR IN THE TURTLE

is to be held at the University of Delaware in the Spring of 1967. Topics to be discussed include:— behaviour in the wild; learning abilities and physiology of sensory systems. Further details may be obtained from Dr. A. M. Granda, Dept. of Psychology, University of Delaware, Newark, Delaware, U.S.A. or from Dr. N. Mrosovsky, Dept. of Psychology, University College, Gower Street, London, W.C.1. England.

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