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ON THE ' PATAGIAL MUSCULATURE ' OF THE SOUTH INDIAN FLYING LIZARD *DRACO DUSSUMIERI*, DUM & BIB.

By

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(*Received* 10/9/69)

Draco dussumieri Dum & Bib., the South Indian Flying Lizard, is unique in having a patagium which can be folded and unfolded, for its arboreal, volant life. As a consequence the trunk musculature, particularly the hypaxial muscles, have undergone profound changes. This paper deals with the musculature of the patagium and the mechanism of gliding of this lizard.

MATERIAL AND METHODS

Specimens of *Draco dussumieri* Dum & Bib. were collected from the field and preserved in 10% formalin and also in a mixture of equal quantities of 10% formalin, alcohol and glycerine. The preserved specimens were dissected and the individual muscles studied under a binocular microscope. In order to study the thin reduced strips of the external oblique and modified intercostals, freshly killed specimens were pinned on a board with the patagium expanded, fixed in Bouin's fluid and then dissected. Fresh specimens were also used. For comparison, the common garden lizard, *Calotes versicolor* was also dissected and the homologies of the muscles ascertained. Gliding mechanisms were studied in the field by observing *Draco* in the actual process of gliding.

RESULTS

The ventral hypaxial muscles consist of the external and internal oblique, external and internal intercostal and the transversus and rectus abdominis, which have undergone profound changes in adaptation to the arboreal and volant life.

External oblique never forms a complete layer of the abdominal wall as in other reptiles. It is represented in the trunk region by very thin slips of muscle fibres, arising from the distal portions of the vertebral osseous part of the thoracic ribs to reach the sternum, and from the dorsal posterior surface of the patagial ribs, at the outer boundary of the ilio-costalis, as thin slips and from the costal cartilages of the lumbar vertebrae. The three anterior slips spread out at the anterior border of the patagium forming a thin ribbon-like muscle, ' rim muscle around the patagium.' The other slips of the reduced external oblique layer also converge towards the margin and join the ' rim muscle.' The cartilaginous sternal ribs of the patagial ribs are embedded in this muscle. Posteriorly the ' rim muscles ' of the two sides are inserted on the fascia of the ischiadic symphysis as normally. Since the margin of the patagium is provided with this muscle, it is elastic and appears frilled when folded. In the lumbar region, the external oblique remains more or less typically reptilian and forms the lateral wall of the abdomen. These muscle fibres arise as fairly thick bundles from the last patagial rib and from all the floating ribs of the lumbar vertebrae. All these bundles run antero-posteriorly and converge to a flat strong tendon, which is inserted on the lateral tuberosity of the pubis (Fig. 1).

Internal oblique is a very thin sheet of muscle which forms the outermost layer on the flanks of the abdomen in the patagial region. This has fibres arising from the ventral side of the proximal one third of all the ribs behind the last to reach the sternum. The fibres run in an antero-medial direction. The anteriormost fibres insert on the xiphisternal horns and the rest insert on the inner fascia of the rectus abdominis. The abdominal wall is compressed by the contraction of this muscle.

Intercostal muscles show very great modification in the patagial region; the homologues of the external and internal intercostals can be recognized.

External intercostals. A thick sheet of muscle extends between the proximal ends of the elongated patagial ribs. The fibres originate from the posterior surface of one rib and from the lateral surface of the vertebral centra. Most of them converge to form a thin flat tendon inserted on the head of a posterior rib at a tubercle near its anterior surface, while the other fibres have long tendons and proceed obliquely, to insert on the anterior surface of the proximal one third of the same rib but distal to the tubercle. This proximal part of the intercostal series is considered the homologue of the external intercostal of other lizards. Here this layer which originates from the vertebral part of the last thoracic rib and reaches the sternum is very thick and massive, and is inserted along the entire anterior surface of the first elongated rib of the patagium. These muscles are the main ones which unfold the patagium. Contraction of the first external intercostal sheet forcefully lifts up the first patagial rib. This is followed by contraction of the following bundles lifting up the other patagial ribs in succession.

In the lumbar region, the ribs are much reduced. Here the external intercostals run more or less in a longitudinal direction, uninterrupted by the ribs and finally form a thin flat tendon inserted on the anterior end of the ilium and the tips of the sacral transverse processes. This part of the external intercostal is called the *quadratus lumborum* and forms the dorsal roof of the abdominal wall in the lumbar region. (Fig. 2).

Internal intercostals. There is a distal sheet of intercostal muscles extending between the patagial ribs, consisting of 10 to 14 separate bundles of muscle fibres in each intercostal space. Each bundle has a wide fleshy origin from the anterior surface of a rib. All fibres of a bundle converge to a long strong slender tendon. The latter courses obliquely antero-medially and is inserted on the posterior surface of an anterior rib. The fleshy part of the muscle is situated near the rib to form a continuous band of muscle. Only the long tendons traverse the intercostal space. The last insertion is at about the middle of the rib and the last origin from the distal part of the osseous portion of the rib. At the point of insertion each long tendon digitates to form a multiple insertion, which elicits a strong backward pull on the rib concerned on folding the patagium. The stoutest last muscle bundle in this series has the strongest tendon. Tendons of the intercostal bundles are widely separated and no membrane connects them. The few tendons present are formed by fusion of a number of intercostal fibres. This effects a drastic reduction in muscle bulk leaving the patagium thin and apparently membranous. This sheet of intercostal muscle is the homologue of the internal intercostal of other lizards (Figs. 2 and 3).

Transverse abdominis, the innermost layer of the hypaxial series, is very thin, closely apposed to the inner peritoneal lining of the abdominal cavity. The fibres are directed transversely and dorsoventrally and originate from the inner surface of all the trunk vertebrae. They insert on the lateral fascia of the rectus abdominis. This muscle, giving strength to the body wall, helps to compress the abdominal wall.

Rectus abdominis forms the ventral series of the hypaxial group. The ' linea alba ' separating the two abdominiis much reduced, almost absent. This muscle which extends from the anterior border of the pubic bones to the posterior surface of the xiphisternal horns is fibrous or membranous in the median region, forming wide fibrous plates. They interrupt the muscle fibres and only the lateral borders are muscular. The primitive segmented nature is retained (Fig. 4).

DISCUSSION

Since *Draco dussumieri* has taken to an arboreal volant life, the hypaxial muscles have deviated from the typical reptilian pattern. In particular the external oblique and intercostal muscles have changed their normal arrangement and function. They do not compress the abdominal wall, nor form the outermost layer of the flanks of the abdomen. The costal cartilages in the patagial region have become elongated and osseous ribs pierce the body wall near the outer border of the ilio-costalis to support the patagium. In consequence the ribs carry with them into the patagial folds the external oblique and the intercostal sheets. In the patagial region of the trunk, the abdominal wall is devoid of supporting ribs. Only the internal oblique and the transversus abdominis form the very thin body wall.

In *Sphenodon* (Byerly, 1925) the external oblique forms a continuous sheet from the pelvic girdle in front of the first or second rib and it is divisible into superficial and deep layers. It originates by digitations from each of the complete ribs behind the second and forms the lumbar fascia. Fibres pass ventro-laterally and insert on each abdominal rib and also by a strong ligament on the lateral tuberosity of the pubis. The internal oblique forms an incomplete sheet over the entire inner abdominal wall covering only the dorsomedial portion of it. In *Uromastix hardwickii* (George, 1948) fibres of the external oblique arise from the two posterior cervical ribs and the costal cartilages of the thoracic and lumbar ribs. The most anterior and posterior few fibres lead more or less antero-posteriorly and the intermediate ones postero-medially. Anterior fibres are inserted on the xiphisternal horns, posterior ones on the pubis and intermediate ones on the 'linea alba.'

The external oblique in *Draco* is much reduced and the remnants have become the rim muscle around the patagium, which borders it. Its contraction helps to expand the patagium and so direct the course during gliding. Similarly the external intercostal, forming the proximal intercostal sheet, on contracting serves to expand the patagium, by raising the elongated ribs upwards while the internal intercostal, forming the distal sheet of the intercostal is much reduced in bulk and on contracting aids in folding the patagium, by pulling the elongated ribs downwards. The reduction in bulk of the external oblique and intercostals reduces body weight, without hampering the functional muscular efficiency and is an adaptation to volant life. Thus the muscles have changed not only their disposition but also their function. The normal function of the intercostals in other lizards and reptiles is respiratory, whereas in *Draco* they act by unfolding and folding the patagium.

The significance of these adaptative modifications becomes all the more important when one takes into consideration the mechanism of gliding in this lizard. In *Draco* gliding is not a mere helpless descent from a higher to lower elevation, which really does not require much manoeuvering. In contrast it is a directed manoeuvre in the sense that the animal can control to a certain extent the direction of gliding and it can also maintain itself in the air for some time by changing the convexity and angle of the expanded patagium, which works like a parachute. This is performed by the modified external oblique layer (rim muscle around the patagium), acting like the ropes attached to the sails of a boat. It has often been noticed in the field that after taking off from a tree, the animal can return to the same tree, but at a lower level. Movement upwards however is not possible. When the lizard lands it takes an upward turn, and its head is directed upwards not down, which would happen if descent were a mere passive descent at the mercy of wind or gravity. *Draco* can glide for about 25-35 ft. at a stretch. The plane of gliding may be at an angle of 20° to 30° from the horizontal plane or even larger.

The rectus abdominis in *Draco* is mostly membranous and very much reduced. This contrasts with its well developed condition in *Sphenodon* (Byerly, 1925) and *Uromastix harwickii* (George, 1948). In *Sphenodon* it is represented by the 'recti abdominis externus' and 'internus.' The former is divided into segments by the abdominal ribs. In *Uromastix* (George, 1948) the right and left halves of the rectus abdominis are separated by the 'linea alba.' In *Chamaeleon vulgaris* (Sathe, 1959, this muscle is absent. Its reduction in *Draco* may be an adaptation either to decrease the animal's weight, thereby increasing its buoyancy or because the rectus abdominis now has no respiratory function (the respiratory function effected by the pectoral muscle) (John, 1966). This conclusion is supported by the fact that the pectoral muscle has undergone a biochemical adaptation at the molecular level (John, 1968). In birds Chinoy and George (1964) showed that in flying birds (e.g. pigeon) the rectus abdominis is well developed; in the non-flying ones (e.g. domestic fowl) it is much reduced and completely membranous. In pigeon fibres of the rectus abdominis show some biochemical peculiarities too. Chinoy and George (1964) suggested that this difference is due to the fact that in flying birds, the rectus abdominis is analogous to the diaphragm of the mammals and helps to compress the abdominal wall in order to increase lung ventilation.

Several attempts have been made by reptiles to make short excursions in the air. One of the simplest is by the Malayan Gecko, *Ptychozoon* where cutaneous expansions of the head, body, limbs and tail act as a parachute. These lateral membranes however are not supported by skeletal structures. Among extinct reptiles *Pterosaurs* were actually flying reptiles. They had large patagia supported by an elongate fourth finger only along the front edge of the wing. Wing membranes were continuous with the lateral skin fold and probably extended back to the hind limbs with no internal supports. Their skeletal features indicate that they were able to flap the whole structure and so probably relied upon soaring flight. In the flying lizard, *Draco dussumieri,* the patagium is unique. The fore-limbs are not directly connected with it for patagia are lateral skin expansions extending to the hind-limbs and supported by six elongated ribs of the trunk vertebrae. Patagia are not moved up and down as in flapping flight of birds and bats; there is only gliding but *Draco* can maintain itself in air for some time by manipulating the patagia.

Though a number of vertebrate groups have attempted flying, only birds have succeeded efficiently and perfectly. Nopcsa (1907) postulated that flight developed in long-tailed bipedal reptiles which flapped their fore-limbs as they ran along the ground. In contrast most workers (Marsh, 1880; Osborn, 1900; Heilmann, 1927) believed that the first birds were arboreal and they developed flight as they leaped from branch to branch. Boker (1927) concluded that the first birds flapped their wings only leaping from branch to branch. De Beer (1954) thought it 'probable that simple gliding preceded flapping.' Parachuting or gliding from tree to tree in *Draco dussumieri* may thus be considered as an unsuccessful attempt at flight which, owing to morphological limitations, came to a blind end and evolved no further.

SUMMARY

In *Draco* the development of a patagium for gliding has necessitated drastic changes in the trunk musculature. The costal cartilages of the 4th to 9th trunk vertebrae have become elongated patagial ribs to support the patagial skin folds. Of the hypaxial muscles, the external oblique is substantially reduced and represented by thin slips which form a 'rim muscle around the patagium.' It does not form part of the abdominal flanks. The intercostals also do not form part of the abdominal flanks in the patagial region. The external intercostals participate in opening the folded patagium; the internal intercostals in folding it. Though the intercostals are much reduced in bulk, there is no functional inefficiency. The rectus abdominis is thin and mostly membranes. The abdominal wall is formed of thin internal oblique and transversus abdominis muscles. Reduction of the abdominal musculature may be related to the loss of respiratory function of the abdominal wall in *Draco,* in association with the development of patagium for gliding.

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KEY TO THE ABBREVIATIONS

Xi.H. = Xiphisternal horns.

P. = Pubis.

Ex.Ic. = External Intercostal.

In.Ic. = Internal Intercostal.

Lon. = Longissimus.

Il.cs. = Iliocostalis.

Sp. = Spinalis.

S.Sp. = Semispinalis.

E.O. = External oblique.

R.M.P. = Rim muscle around the patagium.

P.R. = Patagial ribs.

P.Sk. = Patagial skin cut.

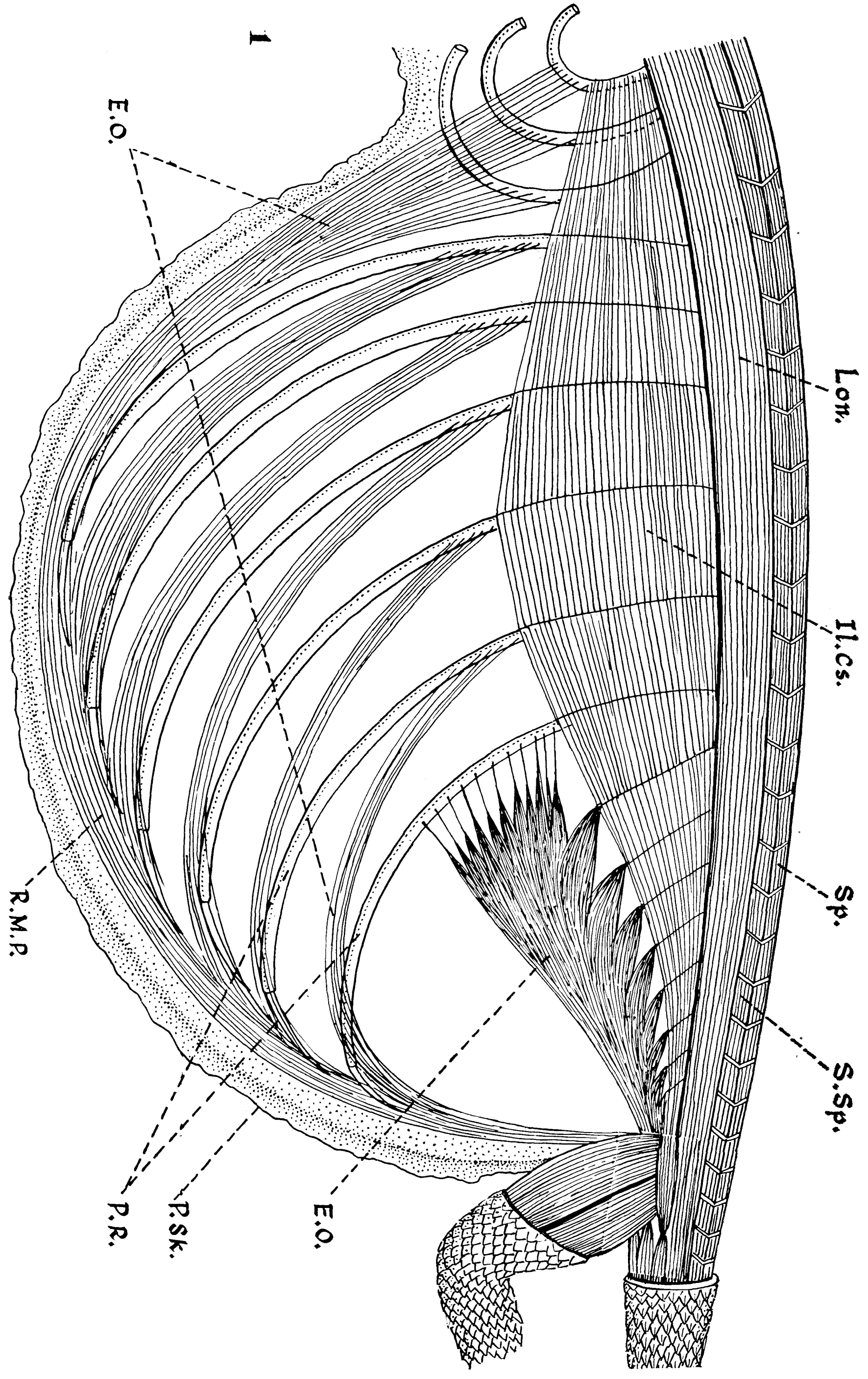

Fig. 1. The trunk musculature showing the external oblique modified to form the 'rim muscle around the patagium.'

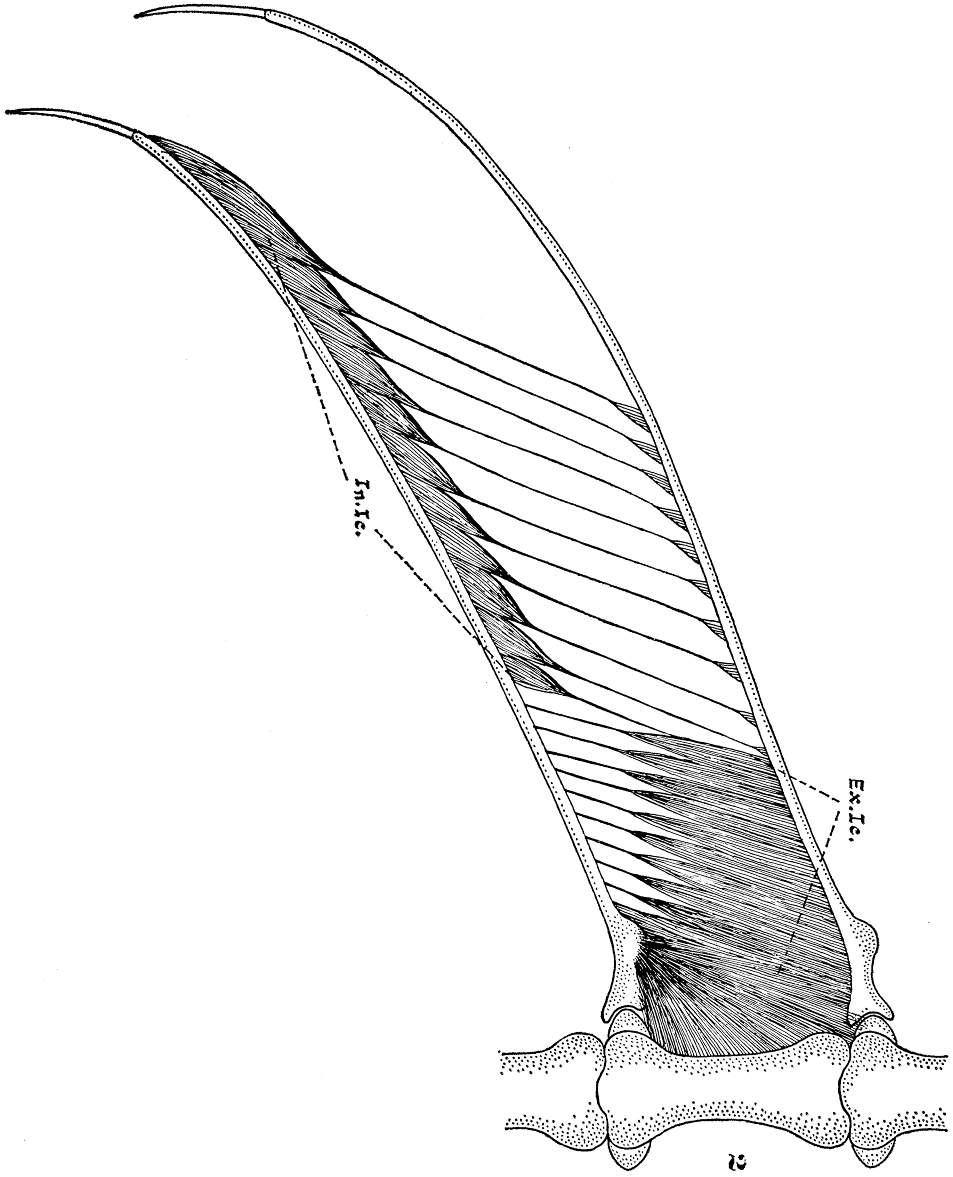

Fig. 2. The intercostal muscles of the patagial ribs.

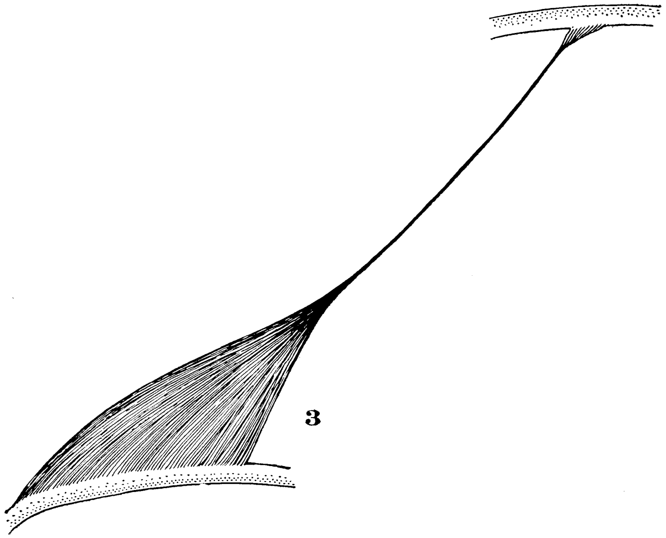

Fig. 3. A single internal intercostal muscle.

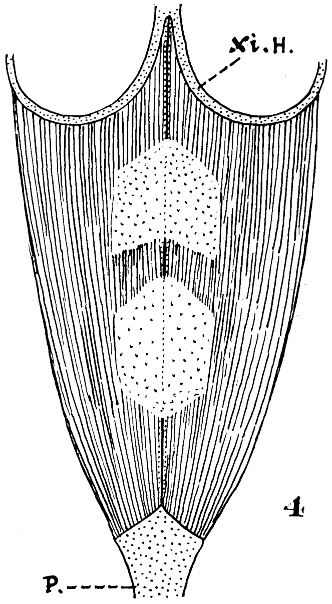

Fig. 4. The rectus abdominis.

'TERRITORIAL BEHAVIOUR' IN THE SOUTH INDIAN FLYING LIZARD, *DRACO DUSSUMIERI*. DUM & BIB.

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During the breeding season, male birds select definite areas in which nests are later built. Allen (1911-13) called such areas 'domains'. Later H. E. Howard coined the more fitting term 'territory', Territorial instinct is very pronounced in birds and they are very keen to defend their territory. The resident male spends most of his time in the territory and drives out other males of his species, even migrant females when they arrive. 'Territorial response' is wide-spread among lizards such as *Chamaeleo hohnelli, Lucasius damaeus* and *Diplodactylus vittatus* (Bustard, 1965), and *Uta stansburiana* (Ferguson, 1966). The present communication is a study of the 'territorial behaviour' which began in 1962 of the South Indian Flying Lizard, *Draco dussumieri*, Dum & Bib.

MATERIAL AND METHODS

Draco dussumieri, the South Indian Flying Lizard, common in many parts of Kerala, breeds during the summer months of February, March and April. To study the 'territorial behaviour' lizards were observed in the field throughout the breeding seasons from 1962 to 1967. Their movements were observed with the help of powerful binoculars. They were also observed in captivity during the breeding and other periods of the year.

OBSERVATIONS

Draco dussumieri maintains a territory of its own as with birds and some mammals during the courting season. Here the 'territory' may be a particular tree or area in a compound. As far as possible their movements are restricted to their particular 'home range' throughout the breeding season. The author observed several pairs of lizards in such different fixed territories and followed them in their breeding throughout the season. No male will deliberately trespass the territory of another male since they maintain and safeguard territorial integrity. The movement of the gular pouch of an intruding male stimulates the 'territorial response' in the resident male and the territory holder immediately exhibits 'a fight behaviour'.

On one occasion, a male following its partner, unknowingly trespassed the territory of another. The territory holder vehemently facing the intruder, displayed its gular appendage, and bobbed his head up and down vibrating the erected gular pouch. The patagium was half-expanded and folded and the excited resident lizard advanced and then retreated, moving first to one side and then the other. Its colour changed to bright silvery grey. The whole display was a real 'challenge' or 'war-cry'. One would be tempted to compare this to the 'fight behaviour' of angry bulls. All this however was merely 'bluff' or 'threat' to intimidate and drive away the intruder. No fighting ensued though there was every opportunity. Failure to fight was probably, partly due to the passive attitude of the intruder. In the beginning the intruder also turned silvery grey and initiated a 'fight display' but discontinued it later and remained for some time calmly viewing all the deliberations of the territory holder and then quickly skulked away from the scene.

The author never observed more than one male courting a female. There is no apparent competition among the males for their partners. Perhaps the competition is only for territory.

DISCUSSION

Bustard (1965) found that males of *Chamaeleo hohnelli* (Steindachner) showed territorial response and initiated combat in which no harm is inflicted; that it was largely 'bluff' and very stereotyped. In this respect *Draco dussumieri* is very similar to *Chamaeleo hohnelli*. Here 'fight display' is merely a 'threat' to intimidate the intruder. Resident males do not even closely approach an intruder. Evans (1951 a) noted that mock fighting is common in many lizard groups and frequently one lizard might defeat another by intimidation alone. Ritualistic struggles during which combatants assume a nearly vertical position has been described as 'pseudo combat' by Deraniyagala (1958) in *Varanus bengalensis* (Daudin).

Carpenter (1962) observed that in *Uta stansburiana,* males display in a species-specific manner and that courtship behaviour may also begin similar to territorial defence. In *Draco dussumieri* too, the 'fight display' begins by the excited folding and unfolding of the gular pouch and head bobbing which occurs in courtship preliminaries also. But the later behaviour pattern is quite different from the curious courtship 'antics' (John, 1967).

Ferguson (1966) studied the factors responsible for release of territorial behaviour in *Uta stansburiana* and found that when the non-resident did not move immediately the attack response of the resident male shifted to courtship, which finally led to attempted copulation. In *Draco dussumieri,* such a behaviour was not seen. Here there is no question of 'trial and error' response, since males are unmiskably distinguished from females by the bright yellow gular pouch and characteristic male behaviour. The movement of the gular pouch and head bobbing are sufficient to elicit a territorial response in the resident male and so the characteristic 'fight display' is released at the intruder. The fight display can even be called 'intimidatory display' since it is meant only to intimidate the intruder and not inflict injury on him. The American Fence Lizard, *Sceloporus undulatus* has procryptic colours on its back; the underside of the males is a clear blue. When meeting another male it displays itself so that the blue underside becomes visible. Noble (1934) showed that the blue belly releases the 'fighting display' in territory holding males. In the male stickleback this is released by the red underside.

The present observations in *Draco dussumieri* and similar ones by others on fight behaviour in other lizards suggest that ritualistic male combat is part of the 'territorial response'. Carr (1963) suggested that male combat in reptiles may be a 'ceremonial way of contesting territory' or a pre-nuptial display. In snakes ritualistic male combats are very common, but there are conflicting views regarding the significance of such behaviour. Klauber (1956) concluded that the male 'combat dance' in rattle snakes stems from some sexual impulse, rather than from one based on territorial defence or social domination. Shaw (1951) also rejected territoriality or social domination as the initiator of male combats. On the other hand, he believed that fights between conspecific male snakes are often attributable to homosexual behaviour by one of the participants. He found such behaviour more prevalent among captives. Though Shaw presented several accounts which describe homosexual behaviour in captivity, conclusive evidence of such behaviour in natural conditions is lacking.

In a recent discussion of the ritualistic male combats in gopher snakes, *Pituophis melanoleucus affinis,* Bogert and Roth (1966) stated that combat in nature may not invariably be a manifestation of sexual rivalry, but negative evidence is inconclusive. According to these authors, neither Shaw (1951) nor Klauber (1956) found sufficient evidence to substantiate assumptions that male combat was either a manifestation of social domination or territorial behaviour. Bogert and Roth (1966) were inclined to agree with Leloup's view (1964) that male combats are associated with mating. Leloup (1964) observed that in *Dendroaspis jamesoni kaimosae* when a rival intervenes or 'persists in his advances', the male momentarily abandons the female he is courting and 'throws himself upon his antagonist'. He doubted whether male combat is to be considered as a 'dance or a symbolic combat'. Bogert and Roth (1966) believe that Leloup's interpretation of male combat as a normal activity that permits males to dispense with rivals during courtship, is the most satisfactory explanation for combats seen in nature; it is taken as a manifestation of sexual rivalry rather than as a reaction to homosexual behaviour of another male.

Information from lizards, particularly species where vision seems to be dominant, may not be applicable to snakes where chemoreception is more important (Bogert and Roth, 1966). Noble and Bradley (1933) reported in captive lizards that 'males frequently copulate males'. Evans (1938) in 2 species of *Anolis* stated 'no single case of homosexual behaviour was observed'. Lowe (1948) recorded fighting among captive *Xantusia* and inferred that this is not related to territoriality. Miller (1951) noted that during the Spring, Summer and early Autumn seldom more than two or three individuals are found within the limits of an isolated branch or in a small pile of debris and that this phenomenon of Spring and Summer isolation is related to territoriality. Zweifel and Lowe (1966) arrived at more or less similar conclusions from an ecological study of a population of *Xantusia*. The present observations on *Draco dussumieri* indicate that 'fight displays' stem from 'territorial response' which is very strong in these lizards. Neither in the field nor in captivity, could the author observe any instance of homosexual behaviour in *Draco dussumieri*, contrary to the views expressed by Noble and Bradley (1933) and Lowe (1948) in other lizards. Such homosexual behaviour in captive lizards may be only an abnormal behaviour under stress and need not be the normal pattern under natural conditions.

SUMMARY

During the mating season males of *Draco dussumieri* show a characteristic 'fight display' comparable initially to the courtship display, but which later switches to a real 'challenge' or 'war-cry'. 'Fight behaviour' is part of the 'territorial response' by the male to safeguard its territorial integrity. The 'fight display' appears to be only a 'threat' or 'bluff' and is meant only to intimidate the intruding, probable rival males. Males maintain and defend their territory throughout the courting season and the fight display is not bound up with mating, but with territory.

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SNAKE ANAESTHESIA

By

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(*Received* 16/2/70)

INTRODUCTION

Snake anaesthesia used to be unreliable. Using halothane[*] in any suitable vaporiser, it is now controllable. Most veterinary surgeons have this apparatus in their operating theatres.

SHORT REVIEW OF LITERATURE

Reports on Anaesthesia for Reptiles are very meagre. Two methods of snake anaesthesia, hypothermia and ether anaesthesia have certain disadvantages. Both have a lengthy induction period and it is questionable whether hypothermia by itself can be described as anaesthesia.

Brazenor and Kaye (1953) report on 15 snakes and 6 lizards in Australia "both for the information of others and as an amusing byway of anaesthesia". They used two methods. The second using muscle relaxants although successful had four drawbacks, the most important being that the snake is conscious but helpless and is thus not anaesthetised. The first method involved the use of ether as a means of induction. 30 ml was squirted onto the floor of a closed snake box and 10 ml increments added as required. Induction took 20-30 minutes. Anaesthesia was maintained by fitting the snake with an ingenious hood. Brook has successfully narcotised snakes in a box using Halothane (private communication) and states that both ether and chloroform in inexperienced hands kill snakes quickly.

Hackenbrock and Finster (1963) are the first to publish a record that halothane is a rapid and safe anaesthesia for poisonous snakes.

Very recently Kaplan (1969) has reviewed the above literature on reptile anaesthesia at far greater length.

REASONS FOR GIVING SNAKES ANAESTHETICS

1. Surgical procedures for tumours, wounds, scale eruptions or to treat damage caused by inexperienced snake catchers.
2. The control of specimens that are disagreeable to handle particularly by veterinary surgeons who may not handle these reptiles regularly.
3. Total immobilisation to make casts for museums.

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[*] Fluothane I.C.I. Ltd.

Special Anatomical and Physiological Considerations

The respiratory system of the snake consists of a long freely movable trachea with its entrance lying on the floor of the mouth.

The glottis is often closed for long periods but is situated so far forward in the mouth that it is readily accessible for intubation.

Only the right lung is functional, the left being rudimentary. The functional lung is in the shape of a fusiform tube occupying the second fifth of the body, it merges at its distal end into the peritoneum and the lung itself is easily ruptured during artificial respiration.

There is no diaphragm.

A study of reptilian breathing shows that lung expansion is controlled by very small expansion of a large number of ribs and in the quiescent specimen is not obvious except under close scrunity. An excited snake is capable of vast multiple rib raising, visibly expanding its body and an equally rapid expiratory effort. Hissing is effected by air being forcibly driven from the windpipe through the very short nostrils and the tongue notch in the front of the upper jaw (Fitzsimons 1962).

Snakes are largely spinal animals with very limited cerebral development. Their metabolic rate is influenced by the diurnal temperature, a relevant factor in the use of hypothermia for their anaesthesia.

Special Consideration Before Undertaking Snake Anaesthesia

Anaesthesia to a stage of total intercostal paralysis would produce complete respiratory arrest and if this stage is reached, means of artificial respiration must be at hand.

The signs of the stages of anaesthesia have not previously been tabulated and it is hoped these notes will be of assistance.

The low metabolic rate will mean that the anaesthetic induction period will occasionally be prolonged as will the recovery period. As was discovered by Brazenor and Kaye, oxygen is most important to assist in detoxication. Increasing the metabolic rate by raising the body temperature by immersing the reptile in tepid or warm water is totally undesirable (Brazenor and Kaye).

The use of the Halothane Anaesthesia

Method

The snake is caught by recognised means and restrained with one hand behind the head. An assistant may hold the remainder of the body fairly straight along the length of the operating table or it can be tucked under the anaesthetist's arm to prevent the specimen from twisting up on itself.

Holding the reptile offers many advantages over the method of leading the anaesthetic gas into a closed box, the most important being that one can appreciate the degree of muscle tone, and the concentration of the anaesthetic is more accurate in a small mask than in a box of varying volume. Halothane, being heavier than air falls to the bottom of a box and a lethal concentration can build up.

The anaesthetic apparatus is that used in small animal surgery with an oxygen cylinder with a flow meter (rotameter unit) operating at 500 ml per minute carrying oxygen over a Goldman halothane vaporiser switched on full. This gives a maximum concentration of about 0.74% halothane at room temperature* 80.6°F (27°C). If a Fluotec Mark 2 vaporiser is used the dial setting should be at 2 at the same oxygen flow rate.

The vapour is carried to a modified Wright's face mask made of perspex with a thick foam rubber collar to fit over the reptile's head (Fig. 1).

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* This report is based on work done in Zambia. At lower room temperatures the Goldman vaporiser does not produce sufficient concentration. Other vaporisers, which are able to produce this concentration, have been used equally successfully in England.

The type of anaesthetic response varies to some extent with the species. The species most commonly anaesthetised has been *Bitis gabonica* (Gaboon viper) and it is the reactions of this placid slow moving species which form the basis for this description. A short comparative description of the reactions of the faster moving species is given later.

Three stages of anaesthesia can be identified.

Stage 1. (stage of analgesia). This stage lasts for about 5 minutes and is the stage of voluntary excitement. The *Bitis* species show a regular caterpillar like movement of the ventral scales with occasional attempts at withdrawal of the head from the mask. No great respiratory efforts are made and the reptile makes no effort to give the typical warning 'hissing'. Muscle tone is good and although in some specimens there are occasional attempts at lateral twisting movements of the body, these are easily controlled by the assistant.

Stage. 2. (stage of delirium). This is the stage of involuntary excitement and lasts for about 4 minutes. Initially in this stage there is muscle twitching in various centres down the ribs. Muscle tone is present but muscle excitability to touch is reduced. Touch produces neither inspiratory efforts nor expiratory hissing but holding the animal behind the vent causes tail twitching and movement. Respiratory movements are difficult to see.

Stage 3. (stage of anaesthesia). This stage is marked by an initial period of complete inactivity and total apnoea lasting for at least two minutes. This is followed by two or three slow deep respiratory movements at intervals of at least one and a half minutes, at the end of which muscle tone has gone and the body shows only a very slight response to touch, even behind the vent. If anaesthesia is maintained at this level by reducing the concentration of halothane but continuing with the same oxygen flow rate the respiratory movements are regular and can easily be identified by the anaesthetist.

At this stage of anaesthesia it is possible to open the jaws with forceps. Great caution must be used however, as in this species the presence of a warm object may initiate a strike with the poison fangs (therefore do not put your fingers near!).

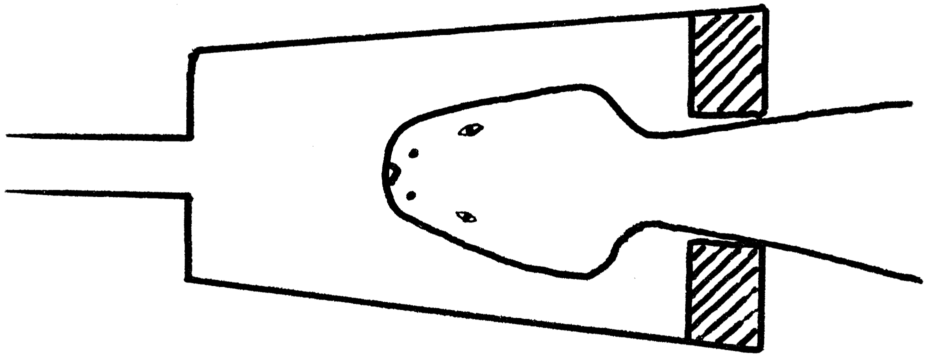

Fig. 1 Perspex face mask with foam rubber collar

Surgical procedures are carried out at this depth. It has not been found necessary to undertake anaesthesia beyond this level, as at this stage it is also possible to open the jaws with 7″ Spencer Wells forceps and examine and treat the mouth cavity for mouth canker quite adequately.

The faster moving species such as *Naja* (Cobra), *Boaedon* (House snakes) *Python* etc., appear to take longer to anaesthetise. In stage 1 the reptile attempts far less voluntary movement and tends to stay quiescent in the assistant's hands, with only slight tail twitching. In stage 2 the muscle twitchings are far less obvious, and the stage lasts longer. Stage 3 is also rather longer and it is about 10 minutes before muscle tone has gone.

All stages tend to be longer on cooler days and this is especially noticeable in winter.

Higher concentrations of halothane have not been used. They would shorten the times in the above procedure but, as halothane is used to produce cardiac arrest in open heart surgery it is not deemed advisable to use too high concentrations until more is known of the effects of such concentration on reptiles.

Should anaesthesia progress beyond stage 3, and total respiratory movement cease, a small 1 to 3 millimetre intubation tube is passed and gentle artificial respiration is given as described by Brazenor and Kaye.

RECOVERY PERIOD

During the recovery period oxygen without any volatile agent must be given until the level of anaesthesia lightens.

SUMMARY

A short review of methods used in the past to anaesthetise snakes is given. Attention is drawn to the special lung anatomy and the physiology of respiration in snakes. A simple method of controllable anaesthesia of snakes using Halothane is described.

A normal Boyles machine found in the operating theatres of most small animal veterinarians is used at a flow rate of 500 ml. per minute. Three distinct stages of anaesthesia are described which can be identified by the animals' reactions.

Oxygen must continue to be given in the recovery period as it is important in assisting Halothane detoxication.

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TRANSPIRATION FROM LIZARDS OF THE CHIHUAHUAN DESERT

By

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(*Received* 20/10/69)

The rates of water-loss by transpiration from snakes and amphisbaenians have been shown to be related to the dryness of the normal habitats of the various species (Gans, Krakauer & Paganelli, 1968; Krakauer, Gans & Paganelli, 1968). Exact comparison with values of water-loss cited in the literature is not always possible because of differences in the techniques employed. Nevertheless, reptiles that live in deserts tend to show very low rates of transpiration compared with those of animals from tropical forests and moist soils, which may lose water at rates equivalent to what is found in amphibians (Krakauer, Gans & Paganelli, 1968).

When placed in dry air in a desiccator (above anhydrous calcium chloride) diurnal skinks. *Mabuya quinquetaeniatus* (Lichtenstein), (weighing initially 7-14 g) lost water at an average rate of about 5 per cent of their body weight for 24 hours at room temperatures of 34°C (± 1°C range), whilst a nocturnal gecko *Tarentola annularis* (I. Geoffroy) (weighing initially 25-28 g) showed a mean daily loss of 3.3 per cent during the first four days under similar conditions. This rate had dropped to 0.1 per cent per 24 hours after 19 days (Cloudsley-Thompson, 1965). The rate of water-loss from the Nile monitor *Varanus niloticus* (L.) under the same experimental conditions, is higher—about 6 per cent per 24 hours. This may account for the predilection of monitors for water (Cloudsley-Thompson, 1967).

Climatic conditions in the Chihuahuan desert of southern New Mexico are not greatly dissimilar to those around Khartoum, although the Nearctic flora and fauna are considerably richer. The rates of water-loss from three diurnal lizard species from this area were therefore measured to see if they were comparable with those from the Sudanese species cited above. The results obtained are given in Table I. From this it can be seen that, whereas *Holbrookia maculata* Girard lost a mean of 4.2 per cent of its body weight per 24 hour in dry air (above activated alumina) at 27°C, *Phrynosoma cornutum* Harlan lost only 0.8 per cent and is therefore much better adapted than either the nocturnal *T. annularis* or *M. quinquetaeniatus*. These observations in no way contradict the hypothesis outlined in the opening paragraph, however, for *M. quinquetaeniatus*, although diurnal in habit, is confined to the Nile valley and is not a true desert species.

The lizards were given access to water after the conclusion of each 4-day experiment. The percentage weights recovered within 5 minutes were as follows:—*H. maculata* after exposure to 27°C—55 per cent; *P. cornutum* after exposure to 27°C—32 per cent, after exposure to 34°C—96 per cent, after exposure to 41°C—44 per cent.

Available time and material permitted only one 4-day experiment to be carried out on a single specimen of each species. These results may therefore not appear very significant. Nevertheless they are probably representative of the species investigated.

Species	Initial wt (g)	Temp. (°C)	Mean Water-loss/24 hrs (%)
Holbrookia maculata Gerard	6.15	27	4.2
Phrynosoma modestum Gerard	6.34	27	2.1
P. cornutum Harlan	65.78	27	0.8
		34	1.6
		41	2.6

Table 1. Transpiration from American desert lizards. Water-loss/24 hrs. expressed as a percentage of the initial weight. Means of four days' exposure in dry, still air at various temperatures.

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A NEW RECORD FOR *UROMASTIX* IN SUDAN

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(*Received* 17/1/70)

In his catalogue of the reptiles of Egypt, Flower (1933, p. 779) cited three species of *Uromastix*:— *U. aegyptia* (Forskal), *U. acanthinurus* T. Bell and *U. ornatus* C. H. G. van Heyden. Of these, only *U. acanthinurus* is known from the Sudan and has been recorded at Wadi Halfa and Dongola. In the collections of the Sudan National History Museum there are also specimens of this species from Tohamyam (18° 20′ N: 36° 35′ E) in the Red Sea Hills. These specimens were taken by Sayed Ahmed M. El Sayed, some years ago.

On 24 Dec. 1969, whilst I was driving across the desert from Omdurman to the Dongola bend of the Nile, a large scaly-tailed lizard, obviously *Uromastix* sp., dashed in front of the Land Rover and disappeared down a deep hole under a large rock. This was about 80Km (50 miles) South from Ganetti, at 17° 10′: 31° 20′ E. The ground in the area was very rocky, and the vegetation extremely sparse. The lizard ran from a clump of grass, *Panicum turgidum* Forssk. I think it was probably *U. acanthinurus*.

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FROG POND CONTAMINATED

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(*First received* 6/8/69)

Introduction: In each spring of 1965 and 1966 over a hundred clumps of spawn deposited in the school pond (Hazelwood, 1969) developed into tadpoles which completed their metamorphosis. In the spring of 1967, although the breeding pattern of the frogs appeared normal, no eggs hatched. On two separate occasions, however, a white detergent-like frothing had been noticed in the pond where field drains entered.

In 1968 again there was no shortage of spawn but for the second successive year no eggs hatched.

In this spring a particularly unusually coloured female frog (unmarked previously) and an almost self-coloured male were isolated in a tank containing fresh spring water and on March 10th laid a clump of spawn of 1,582 eggs which commenced to hatch on March 27th. The tadpoles lay characteristically on the surface of the albumen until becoming active on April 1st. 1,356 eggs (some of which showed early stages of development) failed to hatch, 26 tadpoles were dead and 200 tadpoles with external gills were transferred to a new tank with fresh spring water. Those eggs which failed to hatch stayed on the floor of the tank and only very few were surrounded by albumen except for the initial layer secreted by the anterior end of the oviduct. Of the other tadpoles only 10 completed metamorphosis. They were huge and gyrated as they swam due to a similar deformity of the spine near the base of the tail (Fig. 2). Eight were twisted to the left, two to the right, due to the short spine's lying posteriorly either to the left or right of the mid-dorsal line. This caused the urostyle and ilia to lie at a corrective angle so that the base of the pelvis returned to the mid-dorsal line; articulation with the femora was normal.

On May 21st their weights varied between 0.9 gm. and 1.5 gm. (av. 1.16 gm.). They were fed on Tubifex in their older stages. The average weight of normal frog tadpoles, from other local ponds on June 6th was 0.31 gm. and the "specials" had reached this stage in five weeks less time.

On the whole there was a general decline in weight of the "specials" to the point of death (Table 2), even though the froglets fed freely on favourite greenfly infesting the sycamore leaves or occasionally on smooth caterpillars. They were preserved except for one which disappeared alive on October 11th, 1968.

On March 26th, 1968, following heavy rains a second spawning took place in the School pond but random samples of spawn again failed to hatch in the laboratory, as did a batch laid "in captivity" by another pair of frogs taken from the pond.

"Kinky-tailed" tadpoles were reported by Dr. Marjorie Clark of the West of Scotland Agricultural College at Ayr, from spawn in Loch Doon "where there seems little or no chance of pollution". These eggs hatched "although many larvae outside their own egg cases may have fed on the loose jelly, which was eventually entirely used up. Only about 8% of the hatch had kinky tails" and Dr. Clark inclines to the opinion that the subsequent loss of "nearly all" the tadpoles was lack of oxygen following a high level of activity, coupled with high laboratory temperature.

Other Observations: As eggs traverse the oviduct initially they are enveloped in a gel 0.3mm. thick containing a clotting factor resembling the thromboplastin of blood. The percentage of fibrinogen in mammalian blood and frog albumen is 0.3. In the ovisac the eggs are distributed in a fairly concentrated solution of different protein nature.

After their evacuation inorganic salts from the oviducal secretions are dissolved from the spawn by freshwater and the protein precipitated forms an outer layer of jelly whereupon both layers proceed to imbibe water during the next 24 hours, producing the familiar frog spawn. The outer adhesive layer of albumen is stretched by the swelling of the inner layer and parts except at the places of contact where adherence to adjacent eggs occurs, thus leaving the vertical intercapsular channels free to permit the eggs to be oscillated by water movement assisting individual respiration. The outer layer which does not gel in saline has the property of a globulin kept in solution by salt.

Many twins and triplets were noticed in the pond spawn and on March 20th-22nd, 1968, 115 double eggs were isolated in test tubes of pond water suspended in an aquarium. Mostly twinning comprised two ova bound together by the initial albumen secretion, each egg separately enclosed in a very thin layer. None developed though the outer layers of albumen separated from them and rested at the bottom of the tubes.

Eggs were stripped from three School female frogs and used in batches of fifty ova each. Sperm from male frogs was added to them 1-4 hours after stripping but none developed. In all cases the egg albumen "dissolved" and decomposed leaving scattered ova exposed. Small batches of eggs (approx. 350 each) in the pond behaved similarly.

A normally mated pair of frogs from the School pond, in amplexus, deposited spawn in a tank of fresh spring water on March 25th. Around these eggs the albumen remained intact but none developed (there were three pairs of twins in this batch of 357).

Albumen removed from 150 School pond eggs was concentrated by dialysis a hundred-fold, but the electrophoresis strip bore no evidence of proteins; similar albumen from "foreign" spawn produced a normal protein band.

The "Substance": On July 30th, 1968, following a drought, the School pond was completely dry (fig. 3). The whole central, cracked, mud base was seen covered by a light grey deposit whereas before 1966 this area was always well grassed. Only a few exceptionally long grass stems were seen, appearing as though a selective hormone weed killer had been applied, e.g. S.P.K. *Tubifex* in the mouth of the field drain were enormous.

The entire pond base was then stripped and placed into plastic bags. A day or two later rain fell and the pond refilled once more, giving no indication of what had been seen.

In August 1969 the pond was again dry and apart from one end, the mixed grasses grew luxuriously as prior to 1967. The bare patches still showed a greyish deposit but by early September this part too was clothed solidly by *Polygonum persicaria* with intermittent stems of *Glyceria.*

Bearing in mind the great size of the *Tubifex,* grass stems and the "special" tadpole survivors (fig. 2) growth hormones were suspected as a cause of *Rana* egg mortality. Tests for 2:4 dichlorophenoxyacetic acid were negative.

Pond mud samples were also analysed for residues of the following organochlorine insecticides: Aldrin, Dieldrin, Alpha-, Beta- and Gamma Benzene hexachloride, Heptachlor, pp'DDT, pp'DDE and pp'TDE and for residues of Polychlorinated Biphenyls (P.C.B.s). The organochlorine P.C.B's are not used as insecticides, but are a bi-product of the industrial manufacture of plastics. The method of analysis was Gas Liquid Chromatography, with electron capture detector. This would have detected residues as low as 0.01 part/million of any of these compounds. All tests were negative.

In the spring of 1967 a notice near the Oaks Station (Hazelwood, 1969) stated that weed killer trials were in operation on the railway track. No weed killers have ever been directly applied to the School's playing fields or hedges. Reference to the Public Relations Branch of the British Railways revealed that the double track at the Oaks Station had been sprayed annually for some years with Weedex A (50% Geigy atrazine content). After 1966 an "improved" product (65% atrazine content) was used once annually under Contract (last treated 23.5.68) applied as a suspension in water of the order of 0.006 lb. per yard of single track. ("Atrazine" is 2-chloro-4-ethylamino-6-isopropylamino-1,3,5-triazine). The School pond is approximately 31 feet below the level of the railway lines and in direct drainage line with it. Weedex A is claimed to be "persistent for 12 months or more".

The manufacturers kindly analysed our pond mud samples from 1968 using a "residues method", which involves solvent extraction followed by a highly sensitive gas chromatographic detection and determination technique. This indicated that the level of atrazine was below the ppm range; if it was there at all . . . . The other materials are wetting agents which are notoriously difficult to determine at low levels, apart from their foaming properties, and a filler, chalk, which cannot be distinguished in most soils!

Another method used was to concentrate an extract from pond mud, develop it in iodine vapour and spray with glycine-pyridine when a number of UV fluorescent spots (atrazine is not fluorescent) appeared as well as some iodine vapour positive spots (unsaturated compounds or atrazine), but the spray gave no indication of the atrazine yellow spot. The iodine vapour positive spots indicate what may be breakdown products from atrazine, which involve at an early stage loss of the chlorine atom. This has been shown with closely related Simazine to be brought about by soil micro-organisms which use the nitrogen from its breakdown.

The School Pond 1969. February and March 1969 were bitterly cold, dry, with an almost continuous wind from north or east; the ground was frozen and the pond under thick ice. On March 6th, during an interval of bright sunshine, four frogs moved under the ice and on the following day a peculiar clump of eleven egg-less though perfect spheres of albumen (range 10-24 mm. in diameter) were seen; albuminous adherence was poor.

Heavy snow fell in the night of the 12/13th followed by sleet which melted on the 15th. The ground was sodden and the drains fast flowing but the east wind remained. On the 17th the first 15 clumps of spawn had their upper spheres frozen into the pond ice surface.

On April 10th the spawn present showed all stages of development, some so new that the albumen was not yet swollen. A few "clouded" embryos were recognised in eggs near the field drains.

The constant motion of the pond surface caused clumps to float like large, shallow rafts; poor adherence among the spheres allowed the slightest disturbance to separate them, either to remain free or to rejoin the clump elsewhere. Several tiny independent groups possibly formed in this way. A few small almost spherical clumps lay near the pond bottom, apparently partly supported by grass. Minute particles of suspended clay rested on the albumen, tending to accumulate in the crevice where two spheres adhered. Some large individual spheres contained straight, well developed larvae instead of curled ones.

By April 13th batches of spawn—some large rafts—were at the opposite end of the pond, obviously blown there (fig. 1). The first tadpoles obtained since 1966 were in the process of hatching and 25 of them were transferred to the laboratory (Batch 1, Table 1) and immersed in fresh water from a trout stream. A sample of these spheres measured 16-23 mm. in diameter (normal diameter of 12-13 mm). Four embryos ranged from 10.8-12 mm. and external gills were prominent in the unhatched specimens. These 25 tadpoles all metamorphosed normally.

In spheres of 15.6 mm. diameter adherence was in small circular areas about 4-6 mm. across. The tadpoles separated here and a shallow disc remained attached to their right side behind the gills. These 'rings' were clearly outlined by clay particles possibly left as the water passed through the albuminous vertical channels.

By April 25th the last of the degenerating albumen was seen in the pond and many of the tadpoles metamorphosed successfully and were leaving the pond on June 24th; their tails were still present, very large, but have since disappeared. (See Table I, Control (a)).

Experimental Methods & Results: Twenty-two tanks were set up on March 22nd, 1969, with different combinations of spawn and water; 25 eggs were in each. Spawn used was (a) foreign spawn from ponds outside our area where tadpoles developed normally in previous years and (b) home spawn from the School pond. The different types of water used were:

(i) Freshwater from either the spring (known to support normal tadpole development) or the trout stream on the moors.

(ii) School pond water.

(iii) Top Pond water (near but above the level of the railway line)

(iv) Spring water, 3 litres containing 147 gms. pond mud and residue collected August 1968.

(v) Spring water, 3 litres containing 0.09 gm. Weedex A (50% atrazine). Natural Controls were (a) Home Spawn in the School pond, (b) Foreign Spawn in its native fresh water.

Spawn	Water	Results
Foreign	Fresh (i)	Normal development
Foreign	School (ii)	Spawn hatched; tadpoles normal
Foreign	Top Pond (iii)	All hatched; development normal
Foreign	Mud (iv)	Opaque albumen; none hatched. A Stone Fly larva seemed healthy
Foreign	Weedex (v)	Only 4 tadpoles hatched then died. Slight development in some eggs; others dropped out of the albumen to lie on the tank bottom. The water plants died.

Control (a): Albumen poor adhesion; clumps of spawn became rafts. Spheres of various sizes up to 24 mm. diam. (normal 12/13 mm.) Tadpoles hatched and many metamorphosed. External gills abnormally large at hatching. Tadpoles and froglets three times normal weight. Huge tails on tadpoles.

Control (b): Normal hatch and metamorphosis.

The three batches of 25 home spawn eggs brought from the school pond after varying periods under control conditions (a) resulted as follows:

Batch	Date transferred to freshwater	Period in School pond	Weight 10.6.69	Remarks
1	April 13	Point of hatching	0.14 gm	Normal metamorphosis
2	May 6	3 weeks	0.56 gm	„ „
3	June 10	7 weeks	0.97 gm	

Apparently the longer tadpoles remain in the School pond before transfer, the larger they become.

Table I. Experimental Results (1969)

CONCLUSIONS:

1. Chemicals containing atrazine are known to have been sprayed onto the railway track near the School pond and drainage from this direction enters the pond, situated 31 feet below the track.

2. In 1969 albumen of eggs at the pond entrance of the field drains became opaque; spawn mortality was 100% and here the substance presumably enters the pond—witness the 'frothing' seen in the spring of 1967.

3. Foreign spawn always developed normally (in the various waters used) except in water containing Weedex, or mud and residue from the School pond in 1968.

4. The chemical residue affects eggs before they are laid.

5. When the concentration of the pond residue (light grey deposit) is sub lethal in its action it affects;

(a) the protein content of the albumen decreasing adhesion of the spheres;

(b) accelerates the growth rate of the animal so as to increase its size and to metamorphose in less time. Higher sub lethal concentration than in (a) and (b) leads to

(c) spinal deformity.

6. It is almost impossible to prove the presence of atrazine after its presence in the pond for a few weeks though presumably it had poisoned the water earlier. In some tests positive spots of iodine vapour indicate what may be breakdown products from atrazine.

7. Rats fed on atrazine (known substance and quantities) undergo suppression of albumen in their blood with a rise in B-globulins. (The clotting mechanisms of frogspawn and mammalian blood are similar and the fibrinogen content of both is identical.

8. The effects of atrazine on rat blood disappear when administration ceases. After removal of considerable quantities of pond residue, tadpoles developed into frogs in the newly filled pond although the albumen was not restored to normal.

SUMMARY

It is likely that a substance possibly originally including atrazine drained into a pond used by frogs. This substance affects the quality and amount of the oviducal albuminous secretion of the female frog; the albumen (a) lacks adhesion to eggs and other spheres; (b) has an altered property for imbibition of water; (c) high concentration of the substance results in total mortality of spawn; (d) immediate transferrence of spawn to fresh water may result in the survival of a few deformed tadpoles; (e) the rate of growth of the survivors during metamorphosis is hastened; (f) their ultimate size is approximately three times that of the normal.

From the foregoing this would appear to be a specific case of chemicals (? weedkillers) actually destroying two generations of frogs and had it continued, with no replacement of aging frogs, this natural breeding population would in time have disappeared. Thus though it is known that drainage, buildings and colonisation etc. (hallmarks of civilisation) do destroy or reduce the numbers of natural fauna and flora, this would seem to be a clear example of chemicals, deliberately used for a specific purpose, completely killing off two successive annual reproductions of our limited natural fauna. The lesson is plain. If we wish to preserve many of our indigenous forms then great care should be taken by individuals and public organisations to control the indiscriminate use of poisonous substances; if not, irreparable harm may be done.

No.	*27.5.68*	*May 31*	*June 5*	*June 10*	*June 17*	*June 24*	*July 1*	*July 8*	*July 15*	*July 28*
1	0.93	0.40	0.34	0.37	0.42	0.30	–	–	–	–
2	1.15	0.44	0.41	0.44	0.40	0.35	0.30	0.33	0.33	0.38
3	0.51	0.56	0.23	0.09	0.28	–	–	–	–	–
4	0.75	0.43	0.49	0.44	0.54	0.35	0.36	0.36	0.38	0.39
5	0.615	0.37	0.30	0.29	0.61	0.24	0.25	0.24	0.23	0.28
6	0.76	0.55	0.25	0.26	0.52	0.14	–	–	–	–
7	0.79	0.51	0.32	0.44	0.33	0.27	0.27	0.25	0.26	–
8	0.64	0.45	0.33	0.32	0.38	0.28	–	–	–	–
9	0.74	0.45	0.41	0.33	0.51	–	–	–	–	–
10	0.85	0.53	0.32	0.42	0.40	–	–	–	–	–
Av.	0.775	0.469	0.34	0.34	0.449	0.28	0.29	0.29	0.30	0.35

Table 2. Weights of the 'special' tadpoles, 1968 (grms.).

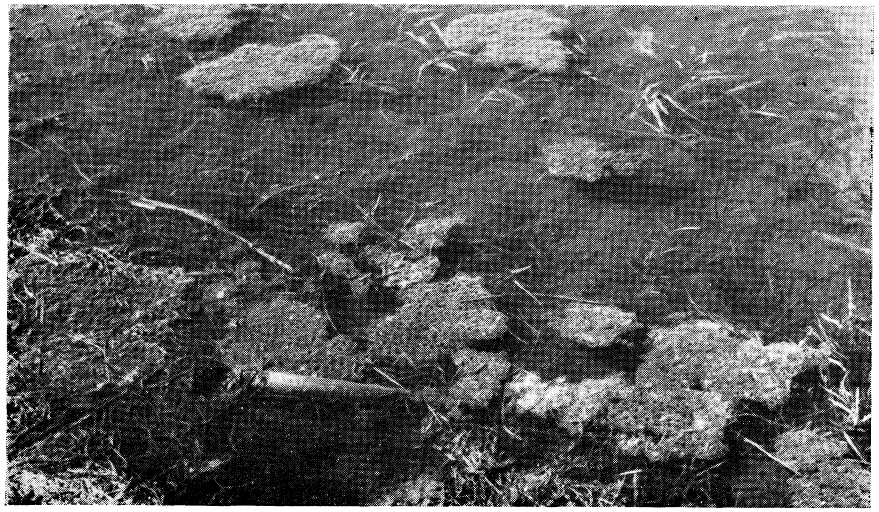

Fig. 1. Clumps of spawn reorganised, like rafts, (10.4.69).

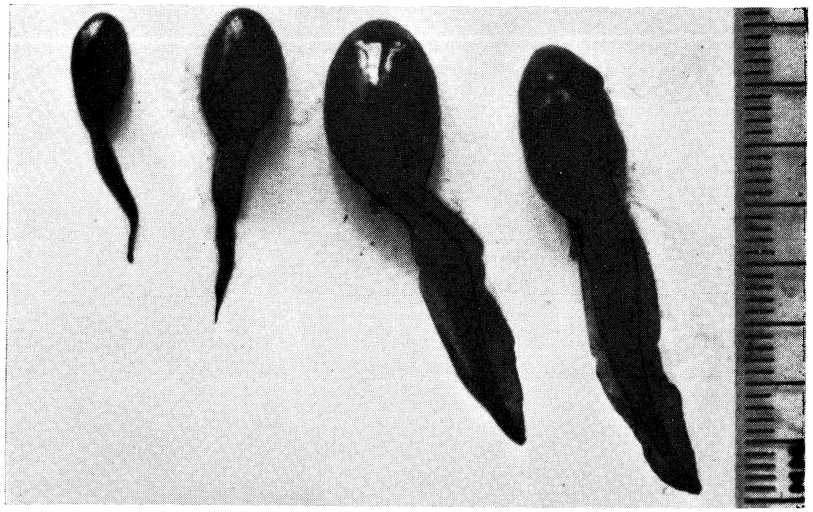

Fig. 2. Tadpoles: Comparison between those of School pond (two on right) Foreign (normal) (two on left).

Fig. 3. Pond, exposed mud with residue, summer, 1968.

ACKNOWLEDGEMENTS:

It is with pleasure that I record my thanks to:— The Boys and Girls of the Canon Slade Grammar School, Mr. J. A. R. Bates (Ministry of Agriculture, Fisheries & Food), Mr. H. C. French (Monks Wood Experimental Station Nature Concervancy), Mr. K. C. Overton (Messrs. Fisons Ltd., Cambridge), Mr. S. Gibbard (Medical Research Council Toxicology Unit—private communication) and Mr. R. H. Horrocks (Bolton Royal Infirmary). I should also like to thank Mr. Brian Jones for his kindness in preparing from my colour transparencies, the illustrations on Figs. 1-3.

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ADDENDUM

Since this paper was prepared, letters have been received referring to the following:

Recorder	*Locality*	*Observations*
J. Pickup	Pontefract, Yorks.	1968. Total mortality of spawn, embryos became opaque, albumen disintegrated.
W. G. Dye	Burbrage Brook, Sheffield.	1969. Spawn hatched, tadpoles larger than usual. Froglets late June to mid-July; 12 (approx 20%) lacked one fore leg or a number of toes from one or more feet.
A. W. Ping	Moorlands, near York.	1969. Frogspawn distintegrated and failed to hatch.
D. Garforth	West Lake, Bretton.	1969. Large spheres of albumen, embryos outstretched within them, prominent gills, very large.
D. Haythornthwaite	Roecliffe brick-yards near Boroughbridge.	Late April, 1969. Tadpoles with "offset tails".

The above resulted from an enquiry at the October meeting of the Vertebrate Section of the Yorkshire Naturalists Union at Leeds.

A FURTHER CONTRIBUTION TO THE HERPETOFAUNA OF THE ISLANDS OF THE ARGO-SARONIC GULF, GREECE

by

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(*Received* 6/5/69)

None of the islands of the Argo-Saronic group has received much attention from herpetologists. The present author previously discussed the reptile life on three of these islands—Poros, Hydra and Spetsai (Clark, 1967)—and since then has made collections on Aegina and Salamis (March 1967 and March 1969 respectively). These finds are reported on here, together with a few more specimens taken on Hydra and Spetsai.

Apart from species listed by the author, there are records from Aegina of *Coluber gemonensis* (Wettstein, 1953) and *Chalcides o. ocellatus* (Wettstein, 1968). Daan (1967) noted *Bufo viridis* on Salamis (also *Ablepharus k. kitaibelli* and *Lacerta trilineata*) but his apparent observation of *L. peloponnesiaca* there is most dubious. The author has commented elsewhere (Clark & Clark, in press) that it is more probable that Daan saw a juvenile *Lacerta trilineata*. With the deliberate intention of finding this lizard, if it existed, the author and his wife spent five days on Salamis and searched many different habitats, particularly in the region of Faneromeni where Daan reported his observation. No wall-lizards were found, even though weather conditions were highly suitable.

The physiography of Poros, Hydra and Spetsai was described in the previous report: that of Salamis and Aegina is now indicated. Like Spetsai and Poros, parts of Salamis are heavily wooded with pine trees, both at sea level and especially over the higher parts of the island which exceed 1,000 feet. There are also more open rocky areas, scrubby hillsides and valleys, cultivated fields and olive groves. Many coastal stretches are extensively built over with holiday bungalows, and still more land is fenced off for development. Even so, large parts of the island remain unspoilt. Aegina is more barren and mountainous with some cultivation.

A list of the species found, field observations and brief taxonomic data and notes are recorded below.

Testudo graeca ibera Pallas:

Three specimens of this tortoise were caught on Salamis and were released after identification. *Testudo graeca ibera* had previously been described from Spetsai and Poros (Clark, 1967), but this identification was erroneous. The tortoise found on these two islands belongs to the species *Testudo marginata*.

Gymnodactylus k. kotschyi Steindachner:

Material examined: 2.

Localities: Aegina (1 adult); Salamis (1 male).

Both specimens had 7 wavy, dark cross bars down the body, these being rather faint in the Salamis specimen. Total length tails damaged; body lengths 49.5 mm., 37.5 mm.; scales across belly 26, 23; rows of dorsal tubercles 11, 10; plates beneath tail X, 1.

The irrelevance of the subspecies *saronica* from Hydra and Salamis (Werner, 1937; Wettstein 1953) has already been discussed (Clark, 1967).

Hemidactylus t. turcicus (Linnaeus):

Material examined: 1.

Locality: Salamis (1 male).

This single specimen was found amongst the stones of an old wall, along with *G. kotschyi*. Another specimen was also seen on Aegina.

Lacerta erhardii livadiaca Werner:

Material examined: 3.

Locality: Hydra (2 males, 1 female).

This small series came from the hillside above the main harbour. It has not been found by the author elsewhere on this island. No further specimens were seen on this occasion (early February, 1969) and *L. erhardii livadiaca* is almost certainly absent from the other islands in the group. Indeed the author strongly suspects that this species has been introduced on Hydra as suggested by its apparently very restricted range there and near absence from the neighbouring Peloponnese and Attica mainland.

Males had a considerable amount of red ventrally and the female had a broad, dull white dorso-lateral stripe. This stripe was much reduced in the males.

Total lengths ♀ 167.5, ♂ 181.0, ♂ 173.5 mm.; snout to vent 54.5, 54.5, 52.0 mm.; dorsals 52, 60, 55; femoral pores 22 + 21, 24 + 25, 24 + 20.

Lacerta t. trilineata Bedriaga:

Material examined: 15.

Localities: Aegina (2 adults, 3 juveniles); Salamis (4 males, 2 females, 4 juveniles).

The material from Aegina was discussed in a more detailed survey of the Green Lizard (Clark and Clark, 1969, in press). Again the Salamis series is simply recorded here as it will be more fully discussed in a future Green Lizard report. It is noted that both plain and striped juveniles occurred on Salamis, but with the latter being more plentiful. Adults were typically large and bright green.

On Salamis *L. trilineata* occurred abundantly in the pine forests near Faneromeni but elsewhere was seldom seen. All but one came from the above mentioned site where 6 were seen in half an hour on one occasion, with an air temperature of 15.5°C.

Ablepharus k. kitaibelli Bibron & Bory:

Material examined: 6.

Locality: Salamis (2 females containing eggs, 4 adults).

This skink was quite common amongst vegetation in most parts of the island. It was also seen on Aegina.

Total lengths 78.5-121.0 mm.; snout to vent 31.5-49.0 mm.; scales round mid-body 18-20.

Coluber najadum dahlii Schinz:

Material examined: 6.

Localities: Aegina (3 males); Salamis (2 males, 1 female).

The Aegina snakes have already been listed (Clark, 1969). These from Salamis constitute the first record from this island. As on Spetsai this snake inhabits partially wooded areas, rocky locations and fields in the neighbourhood of stone walls.

Total lengths 747-889 mm.; snout to vent 518-640 mm.; ventrals 209-224 (anal divided); subcaudals x 2, 117-127; dorsals 19.

Elaphe q. quatuorlineata (Lacepede):

Material examined: 2.

Locality: Spetsai (2 adults).

One of these has already been listed (Clark, 1969). Total lengths 1,327 (tail damaged) and 1,268 mm. (tail damaged); body lengths 1,120, 1,165 mm.; ventrals 209, 204 (anal divided); subcaudals incomplete; dorsals 25.

Both are large, typically marked adults.

Elaphe situla (Linnaeus):

Material examined: 3.

Locality: Spetsai (1 female, 2 juveniles).

Total lengths J 384, J 403, ♀ 815 mm.; snout to vent 320, 330, 674 mm.; ventrals 240, 238, 236 (anal divided); subcaudals x 2, 80, 89, 74; dorsals 27, 25, 25.

Occurring reasonably commonly on Spetsai, this species is as yet unrecorded from the other islands in this group.

Malpolon monspessulanus insignitus (Geoffroy):

Material examined: 1.

Locality: Salamis (1 juvenile male).

Total length 424 mm.; snout to vent 331 mm.; ventrals 171 (anal divided); subcaudals x 2, 80; dorsals 17.

Telescopus fallax (Fleischmann):

Material examined: 1.

Locality: Spetsai (1 adult).

Total length 465 mm.; snout to vent 390 mm.; ventrals 203; subcaudals x 2, 53; dorsals 19.

This is the only record of *T. fallax* from this island group. It was found, dead, during hibernation in a semi-desiccated state and has since deteriorated further.

In his 1967 report, the author presented a list of species known from the islands Poros, Hydra and Spetsai and in the contiguous regions. The opportunity is now taken to compile a revised table for the Argo-Saronic islands.

TABLE to show species from Argo-Saronic Islands.

	Salamis	Aegina	Poros	Hydra	Spetsai
Bufo viridis	+	—	—	—	+
Rana ridibunda	—	—	+	—	—
Testudo graeca ibera	+	—	—	—	—
Testudo marginata	—	—	+	—	+
Hemidactylus t. turcicus	+	+	—	—	+
Gymnodactylus k. kotschyi	+	+	+	+	+
Lacerta erhardii livadiaca	—	—	—	+	—
Lacerta t. trilineata	+	+	+	+	+
Ablepharus k. kitaibelli	+	+	+	+	+
Chalcides o. ocellatus	—	+	+	+	—
Eryx jaculus turcicus	—	—	—	—	+
Coluber gemonensis	—	+	—	—	—
C. jugularis caspius	—	—	—	—	+
C. najadum dahlii	+	+	+	—	+
Elaphe q. quatuorlineata	—	—	—	—	+
E. situla	—	—	—	—	+
Malpolon monspessulanus insignitus	+	—	+	+	—
Telescopus fallax	—	—	—	—	+

+ present; — unrecorded. No speculation is made as to whether unrecorded species might exist.

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A DEFINITE RECORD OF *TESTUDO MARGINATA* SCHOEPFF FROM THE CYCLADES, GREECE

By

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(*Received* 6/5/69)

On a recent collecting trip during April, 1969 to the Aegean island of Paros (central Cyclades), the author found a single specimen of *Testudo marginata*. This is a surprising and unexpected discovery since Wettstein (1953) categorically stated it was absent from this group of islands. The specimen in question was caught, examined and released. It was a male, almost black over the entire carapace, measuring 300 mm. Because of its evident rarity the taking of even a single specimen is undesirable. During the four days spent on Paros, 22-25 April, and on a previous visit at the end of April, 1963, no further tortoises were seen; nor have any been seen during numerous visits made by the author over the past six years to most of the major islands of the Cyclades—namely Andros, Tinos, Syros, Myconos, Delos, Naxos, Ios, Paros, Folegandros, Santorini, Amorgos, Kythnos, Serifos, Siphnos, Kimolos, Polyagos and Milos. This apparent extreme scarcity of tortoises, of any species, from the Cyclades is borne out by the lack of any mention of them in the literature on the area. One early paper, (Heldreich, 1878), does list *T. marginata* from Naxos and while this paper contains several obvious inaccuracies, in the light of this find from Paros, certain other of its records deserve more serious attention.

T. graeca ibera must also be rare or absent from the Cyclades, though it is well known from the offshore Aegean islands of Greece and western Turkey, including Euboia. Again, *T. hermanni* is believed to be absent from the central Aegean islands (Wettstein, 1953). However, Bird (1935) refers to an old record from Syros by Erhard under the name of *T. graeca*. Werner (1930) considers that all records of *T. graeca* (=*T. hermanni*) made by Erhard and Heldreich on the Cyclades are of introduced specimens. Equally, it is possible that *T. marginata* has been introduced onto Paros (cf. introduction of *T. marginata* on Sardinia—Mertens and Wermuth, 1960).

Terrapins (*Clemmys caspica rivulata*) are widely present on the islands of the Cyclades, though specifically have not yet been found on Paros (Wettstein, 1953), where suitable pools and streams abound.

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REARING HATCHLINGS OF DERMOCHELYS CORIACEA L.

The following notes refer to four hatchlings of the leatherback turtle (*Dermochelys coriacea L.*) received by me on the 19th July 1969 from Surinam. The intention was to attempt to rear these hatchlings in captivity if possible for longer than 42 days, which is the record for hatchlings of this species to live under artificial conditions.

Unfortunately I did not succeed in this, as 21 days was the longest time that any one of them survived. However, these notes on their treatment in captivity may be of some assistance to other herpetologists who may obtain this species, which is known to be one of the most difficult of all turtles to maintain under artificial conditions.

WATER TEMPERATURE AND SALINITY

The young turtles hatched from the egg on the 13th July. On the 17th they were shipped to me by airmail post, arriving on the 19th. They were immediately transferred to a 40-gallon tank containing artificial seawater made by adding 1 lb. of Tidman's sea salt to every 12 gallons of water. This was kept at a temperature of between 82° and 84°F., which seems to suit them. At temperatures lower than this they tended to become less active, which would probably have inhibited their feeding mechanisms; on the other hand, at higher temperatures the turtles would expent too much energy in swimming frenziedly back and forth in the tank. The ideal was to simulate as nearly as possible the normal balance of steady feeding and exercise which obtains in their natural environment.

No further additives are required; the usual calcium block normally provided for freshwater turtles is not advised, for two reasons. Firstly, the chemical composition of the water may react unfavourably with that of the calcium block, and this could possibly have an adverse effect on the turtles. Secondly, squid, cuttlefish and other cephalopods (on which *Dermochelys coriacea* feeds) contain sufficient calcium for an additional supply to be unnecessary.

FOOD AND FEEDING

The main food of *Dermochelys coriacea* in the ocean is squid, which is extremely difficult to obtain here. Eventually I located a regular source of supply in a town 21 miles away in an adjoining county, available only one day a week. In the meantime, various other marine foods such as crab meat, shrimp, mussels, cod, etc. were introduced, but the hatchlings were obviously not very eager to sample this temporary diet. Two of them refused it altogether; the others occasionally consumed very small quantities of shrimp only, ignoring the other items.

Squid, when obtained, was fed to them chopped up into small pieces. The two which had already sampled shrimp started to feed normally, but the two on self-imposed hunger-strike continued to refuse food altogether. Paradoxically, the two which refused to feed at all lived longer than the others which were feeding.

Another inexplicable observation is that the feeders did not seem to grow any bigger than the non-feeders. Even allowing for the fact that turtles are slow growers anyway, some slight increase in weight might have been expected to occur. These specimens, together with all the other turtles in my collection, were measured and weighed weekly. All the *Dermochelys coriacea* hatchlings were approximately the same size and weight—4 inches (carapace length) and $2\frac{3}{4}$ oz. respectively (Fig. 1).

None of these specimens ever showed any interest in eating vegetable food, unlike *Chelonia mydas,* which is known to consume a great deal of marine vegetable matter, especially in its first year of existence. Young specimens of *Chelonia mydas* in my collection all devour cooked chopped spinach with great avidity, probably because it looks rather like seaweed!

MOTOR ACTIVITIES

An adult *Dermochelys coriacea* has been clocked at 30 miles an hour from the deck of a ship in the Indian Ocean. This species is in fact reputed to be the fastest-swimming of all turtles; it is certainly the most powerfully-built turtle in the world. A record weight for one of these turtles, a female, is 1,960 lb. (carapace length 10 ft. 6 in.).

The four baby specimens were extremely active and spent almost their entire time racing about the tank. When they tired of swimming from one end of the tank to the other and back again, they tried to get through the glass at one end, repeatedly swimming towards it from a point a few inches away, swimming backwards to this point and then trying again. They would sometimes keep this up for hours, seemingly oblivious of the fact that the glass formed a barrier.

The turtles all died within six days of one another. The first sign of impending death was a cessation of frenzied activity and a tendency to rest on the surface with the head below water, feebly flapping the forelimbs when the head was raised to take in air, which took place at increasingly longer intervals. The two regular feeders also stopped feeding two or three days before giving up the unequal struggle.

There was no apparent cause of death. No lesions of any kind could be found, nor had there been any signs of fighting or other activity which could possibly have contributed towards their early demise.

The following points may be found helpful to herpetologists who may have the opportunity of obtaining these turtles.

WATER TEMPERATURE

This must never be allowed to fall below 80°F. In practice a temperature between 82°-84°F seems to suit them very well.

WATER SALINITY

The particular brand of dried sea salt referred to is recommended as the nearest easily available substitute for natural sea water. Should the herpetologist live near enough to the coast to be able to obtain natural sea water, this is of course preferable.

Aeration and filtration by the usual methods employed by aquarists are not absolutely essential to the well-being of these turtles. The water should be completely changed at least weekly, preferably oftener; all the sea turtles seem to require more frequent changes of water than freshwater species.

FEEDING

The food should be cut up into small pieces; if given in large portions they ignore it completely. The turtles should be fed once daily, towards evening. Always feed them in a separate container, in order to avoid the tank water becoming fouled by the decomposition of uneaten food. The water in the feeding container must be the same temperature as that in the tank.

SPECIAL PROBLEMS OF DERMOCHELYS CORIACEA HATCHLINGS

An American herpetologist has informed me that the aquarium containing hatchlings of this species should be lined with a soft material such as foam rubber, to prevent the development of nasal sores caused by the habit of striking their noses against the glass in the hatchlings' continual and unwearying efforts to escape. I had no trouble of this kind among my specimens, but should nasal sores develop they should be painted with gentian violet.

A point apparently overlooked by my correspondent is that the tank heaters could very easily burn the foam rubber, with unpleasant results.

Hatchlings of this species were never observed to nip one another's flippers, as *Chelonia mydas* hatchlings invariably do. Any wounds so caused should be painted with gentian violet. Turtles will come to no harm if taken out of the water for 20 minutes or so, to allow the lotion time to dry.

SUMMARY

1. Four hatchlings of *Dermochelys coriacea* were received from Surinam on the 19th July 1969, and lived for 21 days in captivity.
2. The feeding and movement patterns of these hatchlings were studied, and their weight and carapace length recorded at seven-day intervals.
3. The food preferences of hatchling *Dermochelys coriacea* in captivity were noted, and feeding patterns recorded.
4. Some additional notes were appended for the guidance of herpetologists attempting the difficult task of rearing this species in captivity.
5. Treatment of any sores or other wounds has been discussed, in the event of such treatment becoming necessary.

ACKNOWLEDGEMENTS

I am indebted to Mr. Peter C. H. Pritchard, of Florida University, for assistance in obtaining specimens of this turtle, and for advice on its treatment in captivity. I also wish to thank the Editor of the Northampton Chronicle and Echo for permission to reproduce the photograph at Fig. 1.

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(*Received* 12/12/69)

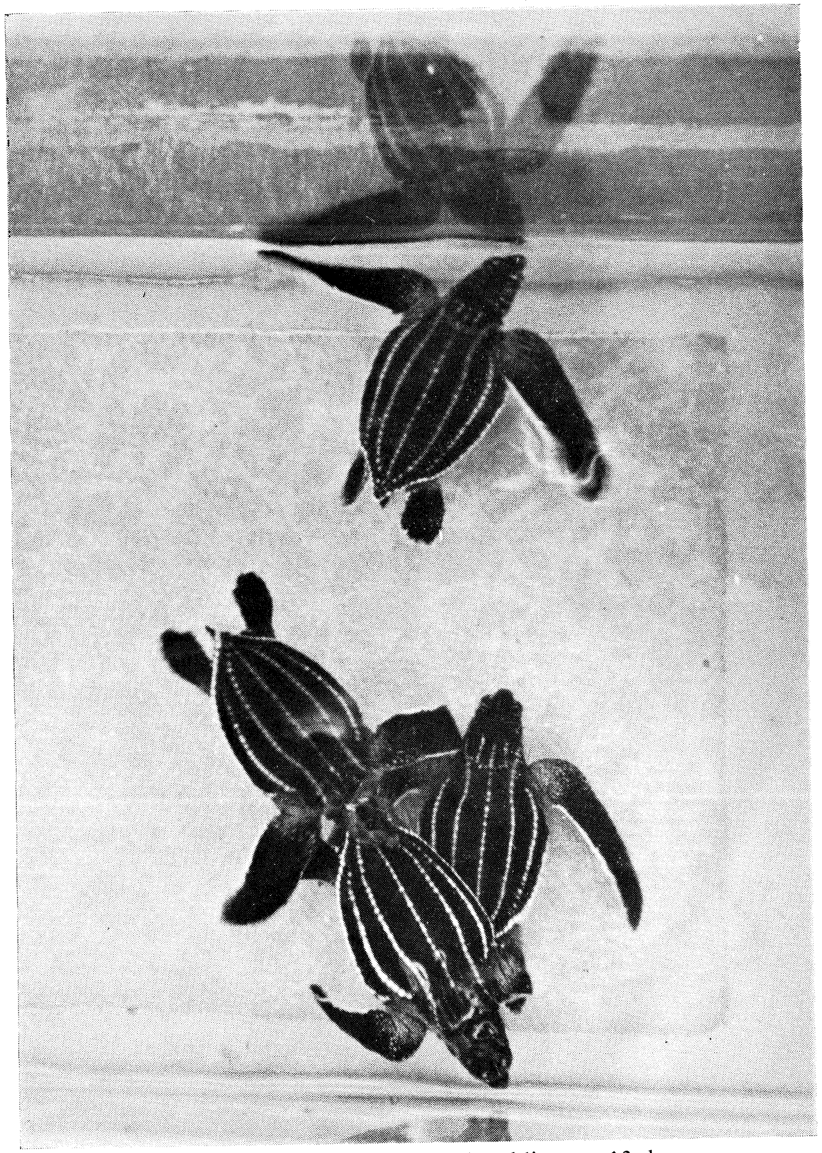

Fig. 1 *Dermochelys coriacea* hatchlings at 13 days

LETTER TO THE EDITOR

I hope no one will employ the method used by Nickerson (*Brit. J. Herpetol.*, **4**, 138, 1970) to sex live snakes without the modification I suggest. The injection of water into muscles is extremely painful and causes considerable damage to the tissues. It is obviously safer to use isotonic saline (0.9% sodium chloride in water) for injection and this should be sterile and preferably free from pyrogens. Sterile saline can be purchased (Sterivac No. 1, sodium chloride injection B.P., Allen & Hanburys

Ltd.) but if this is not available the saline can be quickly boiled. The syringe and needle should be heated (for several hours at 105°C) or boiled before use and the skin swabbed with 70% ethyl alcohol before and after the injection. Finally, I would not recommend this method to people not accustomed to making injections.

M. Peaker,
Agricultural Research Council,
Institute of Animal Physiology,
Babraham, Cambridge.
22/7/70

BOOK REVIEWS

Biology of Amphibian Tumours. M. Mizell, Ed. Springer Verlag, 1969, pp. 484. Figg. 186. Price $24, bound.

As a " special supplement " to their range of ' Recent Results in Cancer Research ' Springer publishes the papers read at the 1969 Symposium on Amphibian Tumours held at New Orleans under the auspices of the Tulane University. For more than one reason this book will only have a limited distribution. Only wealthy libraries will be able to pay $24 for a book which can only present the present transitory state of a field which is in rapid development. For many readers, not personally concerned with the intricacies of virus research, the summary, provided by K. Habel will be all the information they require. Furthermore the book will not be an easy source of information since, surprisingly in a publication of this size and this price, no indices of authors or of subject matters are provided. As a collection of 42 papers on tumour virology in the Amphibia the book will find its place on the shelves of those laboratories active in this field. Some time, in the future, we shall definitely know all about the part viruses play in the production of amphibian tumours and we may then look back on this book to see how much or how little we knew about the subject in 1969.

E. Elkan

The African Clawed Toad. Brown, A. L. 1970. Butterworths, pp. 140. Price 18/-.

It is a pity that this well written and useful book was not published ten or twenty years ago when *Xenopus laevis* was the most useful means of quick and reliable pregnancy diagnosis and when nearly every laboratory struggled to keep small or large stocks of these anurans alive and in good condition. *Xenopus,* however, is such an eminently suitable laboratory animal that we can only hope that it will be permanently introduced into the classroom there to replace *Rana temporaria* and other European species which are becoming more and more depleted. The book under review has been written with this aim in mind and it certainly contains all the information required. No two authors, working on *Xenopus,* will ever quite agree on all the procedures required. Personally I find the injection method suggested on p. 74 far too clumsy and time consuming and having, in the last 20 years, injected many thousands of toads, I can strongly recommend injection through a wide mesh net and to avoid holding the toad with dry towelling which provokes the exudation of mucus and is obviously distressing to the toad. One might also, in future editions, add to the reading list the bibliographies published by Shapiro and Zwarenstein, if only because they contain Hogben's original note which drew our attention to the usefulness of this species.

E. Elkan

Biology of the Reptilia, Volume II, Morphology B. Gans, C. and Parsons, T. S. (Eds.), Academic Press, 1970, pp. 374. Illustrated. Price 110/-.

Volume II of this important series maintains the standard of volume I. We now have detailed reviews of the present state of knowledge of the cranial sensory organs as follows: The Eye (G. Underwood), The Nose and Jacobson's Organ (Th. S. Parsons), The Ear (I. L. Baird), the Pit Organs (R. Barrett with appendices by P. F. A. Maderson and R. M. Meszler) and a resumé of the taxonomic reptilian literature by the editors of the volume.

A book of this kind, already heavy in weight and in price, cannot answer every question the research worker might want to ask. Its great value lies in saving him the trouble of scrutinizing endless volumes of past issues of herpetological journals when investigating any of the many as yet unsolved problems of reptilian anatomy, physiology or pathology. While our knowledge of *Homo* and the higher vertebrates is well advanced, our scientific investigation of the lower Vertebrates is only in its infancy. The Pathologist, for example, would like to see a large colour Atlas illustrating nothing but the normal range of tissues in fish, amphibians and reptiles. Human histology is more than well represented on our shelves but we have not a single modern comprehensive Histology dealing with the cold-blooded animals. The present volume is very much a step in the right direction and we are looking forward with the greatest interest to what the future may bring.

E. Elkan

Desert Biology. Ed. G. W. Brown, Jr. Academic Press, New York and London, 1968. Volume I, pp. 635.

This is the first volume of a two-volume treatise dealing with the physiological and biological aspects of the world's deserts. The present volume is written by eleven contributors, mostly American and all recognized authorities in their respective fields, and deals in considerable detail with the varied evolution of deserts and their plant and animal inhabitants. From the biological point of view, there is extensive information on the morphological and behavioural adaptations enabling different species (including man) to cope with the harsh conditions imposed by aridity, wide temperature range, frequent shortage of food and the general " wide-open " nature of deserts. Desert reptiles and amphibians are well covered in a chapter on their biology by W. W. Mayhew and another on the venoms of desert animals by S. A. Minton, Jr. The references are exhaustive and there is a good index.

J. W. Steward

The Tailed Amphibians of Europe, by J. W. Steward. David & Charles, 1969, 42/-.

Many members of the British Herpetological Society already know of Mr. Steward's herpetological interests. He has now produced the only book to deal exclusively and in detail with the tailed amphibians of Europe. After a chapter dealing in general with the evolutionary history of the Amphibia, he provides a general survey of the modern species, relating their present-day distribution to their former refugia during the Ice Ages. Following this are brief accounts of each species and subspecies. These are all listed, and each is shown in drawing or photograph. There is also a series of distribution maps. A glossary gives the local names in eight European languages.

The merit of this book lies not only in bringing together facts about the newts and salamanders which have hitherto been found only by looking at a variety of publications, but in leading the reader further. Facts about the ecology of species, genera and families should lead many readers to explore the references, and so to find their way further afield. This book should inspire many to seek deeper knowledge on the species it covers.

J.F.D.F.

THE LIFE OF REPTILES, by Angus Bellairs. Weidenfeld & Nicolson, London, 1969. Two volumes, 590 pp., 48 black-and-white plates, 149 line drawings. Price 70/- each volume.

This book in two volumes is a further addition to the Weidenfeld & Nicolson Natural History series. This is a pity only in that the title has presumably been chosen to fit in with the series, and might suggest a rather more restricted field than the book actually covers.

Having read every word of the book's 590 pages, I finished up most enthusiastic about it, for two main reasons. One is that the author has succeeded in doing what so many authors on technical subjects try but fail to do. He has written a book which is detailed and authoritative enough to satisfy any zoologist, but in a style which makes it sufficiently readable and clear for anyone. The other is that it brings together so much up-to-date information not previously available in one book, that it will remain a valuable and exhaustive work of reference for a long time to come, and such books do not happen very often.

As might be expected from this author, there are detailed and well-illustrated chapters on every aspect of the physical features of reptiles, including their evolution and adaptation to habitat and behaviour. Similarly informative chapters deal with the nervous system, psychology and sense organs; sex and reproduction; embryonic development (with a short but adequate account of the recent discoveries of parthenogenesis in certain lizard species); growth, age and regeneration; and enemies and defence. There is little one might want to know about reptiles as forms of wild life which is not covered somewhere in this book. There is a useful classification of living reptiles (with a general indication of distribution of various forms), a bibliography of nearly 500 references, and a detailed index.

At £7 for the two volumes, the book may seem a little expensive. I feel sure that any herpetologist who can afford to buy it will find that he has got unusually good value for his money, and no serious herpetologist, however specialized, can afford to be without it.

J. W. STEWARD

REVISED ANNOTED CHECKLIST WITH KEYS TO THE SNAKES OF HONG KONG. J. D. Romer. Memoirs of the Hong Kong Natural History Society, No. 8, June 15, 1970. Copies at 8/- each may be obtained from the Hong Kong Natural History Society, c/o Department of Zoology, University of Hong Kong, Hong Kong.

The list is revised from 1961; six additional species have been recorded and additional specimens of four other species, each known from Hong Kong from a single specimen, have been found in the Colony. A list of references is cited.

H. FOX

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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.