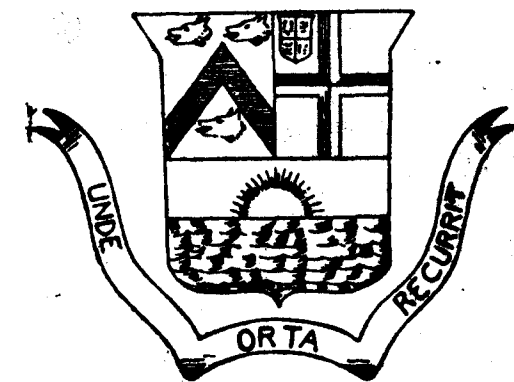


The
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Zoology Magazine

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THE
Presidency College Zoology Magazine

Editor :—MR. K. E. GEORGE, B.A.

Associate Editor :—MISS. M. SAMUEL, B.A.

Vol. IV]

[DECEMBER 1937

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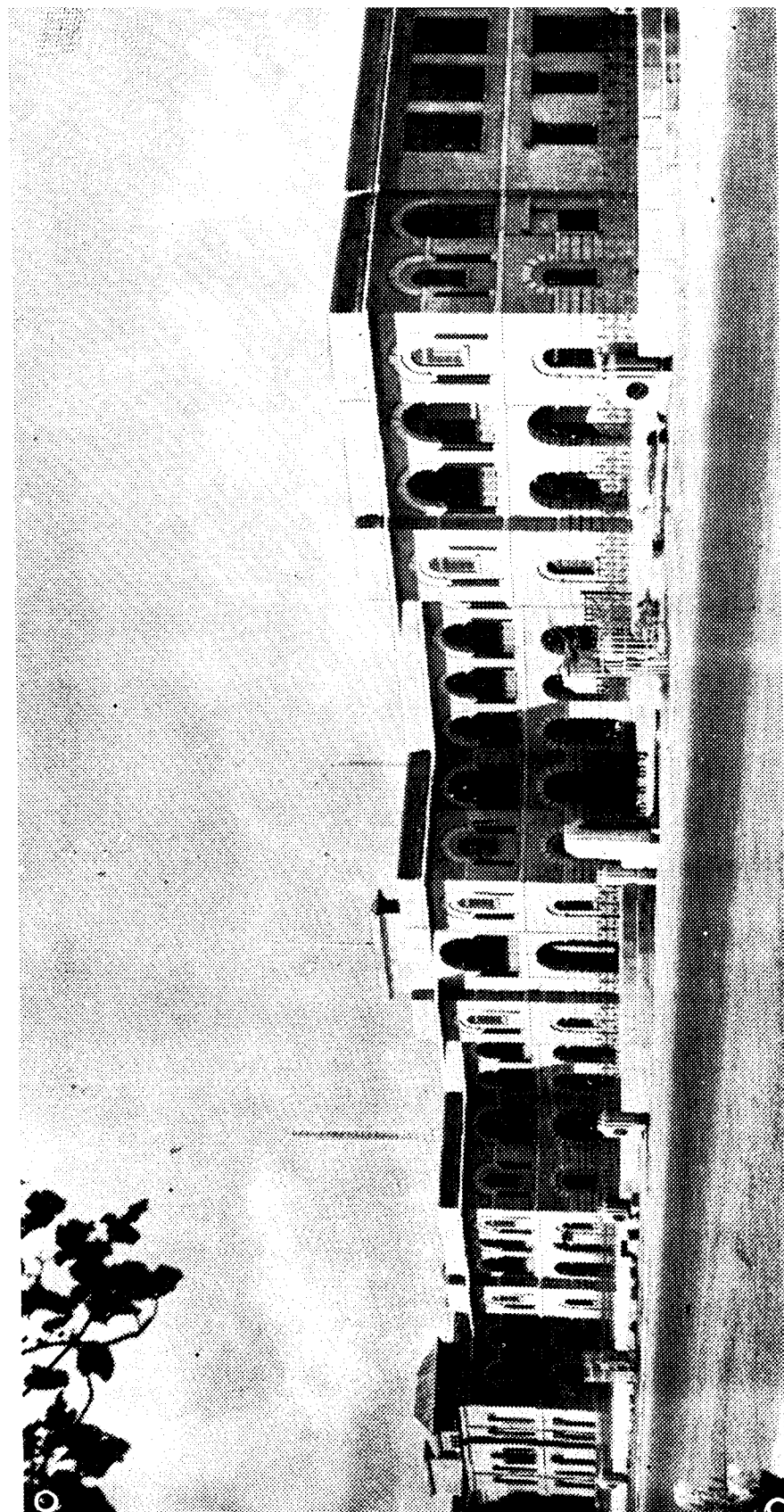
IN presenting the 4th number of this Magazine we have great pleasure in thanking the contributors who have kindly responded to our request. This year, we are indeed lucky in getting a few articles from the old students of the Department.

We also take this opportunity to express our respectful thanks to our Chief, Additional, and Assistant Professor for so kindly scrutinizing the Mss. before going to the press, and for the invaluable advice given to us for the successful publication of this issue.

It is also gratifying to note that a few eminent Zoologists abroad have promised to contribute articles for the next issue of this Magazine, and we thank them in anticipation.

Our thanks are due to the printers who have spared no effort to make their part of the work successful.

ZOOLOGY DEPARTMENT, }
13th December 1937.



The New Natural Science Block declared open by H. E. The Governor of Madras.
(By the kind permission of "The Hindu".)

Respiratory Mechanisms of Amphibia and Reptilia.

BY C. P. GNANAMUTHU, M.A., D.SC., F.Z.S.

IT is well known that the fishes aerate their gills by enlarging and contracting the pharynx whose wall is supported by a number of branchial arches, and that these arches are made up of cartilaginous or bony pieces capable of movement owing to the attachment of the branchial muscles. It is this branchial skeleton and its muscles which persist as the hyoid and its muscles in the batrachia and these muscles together with those of the chin, mouth and the anterior part of the body, are responsible for the ventilation of the lungs in the Amphibia, Reptilia and later in the homiothermal Aves and Mammalia. In this paper, a few notes and observations on the breathing of frogs, lizards and turtles, not found in the text books, are presented to facilitate a complete picture of the evolution of the costal mechanism of respiration.

Breathing mechanism of Frog.—Though the anura may not be typical of the amphibia, so far as the direct line of evolution of the reptilia from the fishes is concerned yet the hyoid apparatus as well as a lack of a thoracic skeleton are characteristically amphibian. The hyobranchial skeleton of the fishes has given place to a flat plate of cartilage with fixed processes representing the branchial arches. The form of this plate as well as the disposition of its muscles enable the mouth floor to be elevated and lowered and thus alternately compress and dilate the mouth cavity. The thoracic region of the body wall, however, is not supported by a costal framework but just consists of two layers of muscles of opposing dispositions. These two muscles (a) *M. obliquus externus* (especially its anterior division *portio omo abdominalis*) and (b) *M. obliquus internus* or *transversus*, are responsible for the compression of the body cavity and therefore of the lungs.

The role of the buccal floor is actually much simpler than has been described in text books. The air currents going out of and entering into the nostrils when recorded on smoked paper show that they are continuous, regular and uniform. The

oscillations of the mouth floor when made to trace a graph also show that they are ceaseless, unvarying and of the same magnitude: further a combined graph shows that when the mouthfloor is elevated—the air rushes out of the nostril and when it is lowered, the air is inhaled. The lungs continue to inflate and deflate regularly and uniformly whenever the buccal floor moves; further a combined record shows that whenever the mouthfloor rises and falls, the lungs fill and empty and whenever air enters the lungs from the mouth cavity, it goes out of the nostrils also. From these various experimental observations, only one conclusion is derivable—that when the mouth floor is elevated the air in the mouth cavity is exhaled through the nostrils and inspired into the lungs and when the buccal floor is lowered and the mouth cavity is dilated, fresh air is inhaled through the nostrils and impure air is sucked out of the lungs and that the mouth cavity is thus filled with air of a mixed character.

From the graphs traced as above it may be concluded that the buccal cavity is a very important factor in the respiratory mechanism; but that it is not the only factor will be evident when the mouth of a frog is artificially prevented from closing and the buccal cavity is thus thrown out of action. The frog executes a series of expirations until the lungs shrink to their smallest size. Beyond a certain limit, the flanks can be seen to contract periodically executing short active expirations. Following each such contraction of the flanks, the thoracic wall and lungs passively expand and slow passive inspirations result. The frog can thus live for a considerably long time without any danger of asphyxiation, whatever text book writers may say to the contrary. The co-operation of the flanks and buccal cavity suggest an easy transition to the respiratory mechanism of reptiles. Among the reptiles, the lacertilia and the chelonians are of considerable interest as far as the breathing mechanism is concerned.

Lacertilia.—Among the lizards, the Geckonidae are acknowledged to be one of the primitive families. *Hemidactylus gleadowi*, a member of this family can be easily observed in houses.

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If we watch the house-lizard breathing, we will find its buccal floor oscillating rapidly and the flanks also moving as quickly. Whether these two movements are synchronous or alternating it will be difficult to see with the unaided eye; hence the following method can be adopted—a lizard is laid flat on its back, secured by twine to a board and the movements of the buccal floor and flank are made to break and complete two separate electric circuits. The bells fitted into the circuits ring together showing that the movements synchronise. Further if the throat region is narcotised and the windpipe is severed—the movements of the buccal floor are as active and frequent as before. The facts show that the buccal floor plays an active role in the breathing mechanism most probably helping the flanks to expel the impure air completely out of the body and avoiding the mixing in the mouth. In the more advanced or specialised families like Agamidae and Varanidae, the buccal floor is far thicker and muscular and the exhalant and inhalant air currents are not impeded by the mouth cavity except by very feeble alternate movements of the throat. But if the nostrils are plugged or the thorax tied by twine, and extraordinary respirations are thus induced, the buccal floor is pressed into service and synchronous movements of the mouth cavity and thorax, similar to those ordinarily observed in the house-lizard become apparent. These facts indicate that in the lizards the buccal floor aids the action of the thorax in expelling impure air out of the body which is the active process in the Sauropsida.

Chelonia.—When we come to the chelonia we find a strong suggestion of amphibian conditions; while the amphibian thorax is feebly muscular, the thorax of chelonia is fettered by the development of a bony carapace and plastron and is equally dependent on the co-operation of the buccal cavity in respiration. The mouth floor is moved up and down—in a way which alternates with the air currents from the nostrils and from the lungs—clearly suggesting such a co-operation of mouth floor and trunk muscles, as we are familiar with in the frog.

As the ribs have fused with the carapace, the lungs are compressed not through the costal mechanism, nor by the alternate withdrawal and extension of neck and limbs as is described in text books but by the rotation of the girdles and by the contraction of ventral trunk muscles such as *M.m. transversus*; *diaphragmaticus* and *obliquus*. But the buccal cavity is of considerable importance in respiration. The hyoid apparatus reaches a very high degree of development and efficiency. It consists of a basal plate to which two pairs of processes, the posterior cornua and basibranchials are very movably articulated. These two pairs of appendages are similar to the ribs of mammals and like these can distend the buccal cavity in depth and breadth whenever displaced (Vide figures). Owing to such

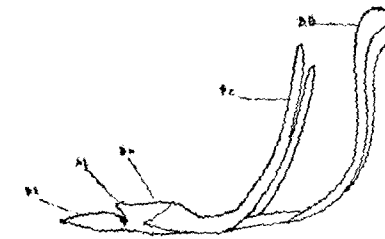


Fig. 1. Lateral view of Hyoid Apparatus of Emyda.

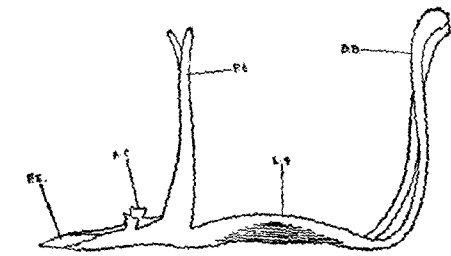


Fig. 2. Lateral view of Hyoid Apparatus Extended.

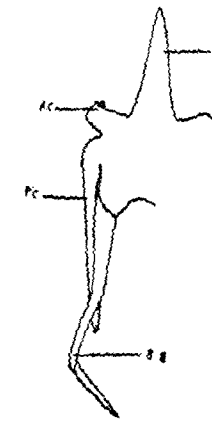


Fig. 3. Ventral view of Hyoid Apparatus of Emyda.

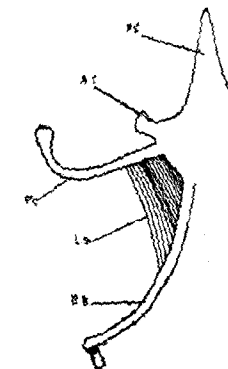


Fig. 4. Ventral view of Hyoid Apparatus Extended.

VIEWS OF HYOID APPARATUS OF CHELONIA: A. C. = Anterior Cornua. B. B. = Basi Branchials. L. S. = Ligament Sheet. P. C. = Posterior Cornua. P. E. = Processes Entoglossus.

displacements the basihyoid is also drawn back and this increases the buccal cavity in the to and fro axis also. Such a distension of the mouth cavity coincides with the compression of the lungs or expiration. When the buccal cavity contracts the air escapes through the nostrils as well as into the trachea. This is tested by applying an air-tight funnel-like mask to the snout and recording the air currents on smoked paper with the aid of tambour, levers, etc., and by severing the trachea, after injecting the region with *novocain*, and recording the air from the buccal end of the trachea.

During extraordinary respiration also, the buccal cavity plays a very important part in pumping air into the lungs. [Owing to the enormous volume of air given out and taken in during this, a mercury manometer was used for recording]. The graphs of extraordinary respiration clearly indicate the important role played by the buccal cavity in inspiration of air.

It will thus be seen that the prominent part played by the buccal cavity in the respiratory mechanism is suggestive of a resemblance to the amphibia. As the chelonia are characterised by a number of morphological features of a clearly primitive character among the reptilia, it may be wondered whether this resemblance in the respiratory mechanism may not be a persistence of the characteristics the reptilian ancestors had in common with the amphibia. But it will have to be remembered that the chelonia are distinguishable from their very earliest appearance by the development of the confining carapace which appears to be closely associated with the modification of ribs. The ribs certainly ought to have introduced a higher type of breathing device than what is found in the amphibian level. Hence it is probable that the vigorous participation of the buccal cavity in the respiration of the chelonia is a secondary feature correlated with the immobilisation of the ribs.

The air breathing habit in certain Fresh water fishes of India.

BY G. KRISHNAN, M.A.

It has been known from very early times that certain fresh water fish are capable of living on land for considerable time. As far back as the 1st century A. D., the elder Pliny remarked on the habit of certain fishes of Ganges to migrate over land to breed in isolated pools. The earlier Scientists like Cuvier, Owen, and Gunthur explained that the fish were enabled to undertake such migrations on account of their ability to store up water in special cavities by which the gills were kept moist. Later Hyrtl (3) and Day (4) showed that the cavities in question contain little or no water and they are really accessory air-breathing organs. It was further shown that these fish even when in water require to breathe in air directly in the absence of which, they are drowned and show all signs of asphyxiation.

The air breathing fishes retain the air bladder which however is functionless as an organ of respiration, and the air breathing organ is a new development in each case, independent in type and origin. The accessory air breathing organs though diverse in structure and development, all subserve the same physiological need and so certain common characteristics could be traced through them.

The conditions under which the need for air breathing arises and is solved, are important for understanding the evolutionary origin of these air breathing organs. The air breathing fishes usually inhabit shallow streams and stagnant pools which during the hot season more or less dry up or the waters become foul and muddy. Apart from a seasonal impermanance of the fresh water habitat in many cases, the most general condition to which all these fishes are subjected is the low concentration of dissolved oxygen in the water in which they live. The survival

of the fishes is therefore conditioned by their ability to utilize atmospheric oxygen and most of these are so adapted by developing accessory breathing organs.

The criteria for aerial respiration in these fishes are (1) that air is passed continually in and out of the air breathing organ (2) that a capillary network is present to enable gaseous exchange to take place between the blood and air and (3) the presence of concomitant changes in the vascular system for the supply of impure blood for purification and transport from the organ of purified blood.

The fishes that possess accessory respiratory organs also possess gills which are capable of functioning. A question of importance is how the functions of two organs are related to one another in performing the total respiration of the fish. Analysis of gases from the organs of aerial respiration in fishes, has always shown a very high percentage of oxygen as compared with the proportion of oxygen in the alveolar air in the lungs of mammals. It is found that while in the lungs the absorption of oxygen is approximately equal to the excretion of carbon dioxide, in most of the accessory air breathing organs it is at least 5 times as great (2). This shows the relative effectiveness of these organs as absorbers of oxygen and the other respiratory exchange, namely the excretion of carbon dioxide appears to be effectively carried on by the gills. Calugareanu (2) came to this conclusion in *Misgurnus*. Such a view is not surprising when we find that according to Krogh (2) in the frog greater part of excretion of carbon dioxide takes place in the skin while the absorption of oxygen is carried on in the lungs. It is contended that the accessory air breathing organs are developed in response to a shortage of oxygen and since the gills can carry on the excretion of carbon dioxide effectively, the physiological need is therefore only for more oxygen, rather than for a general increase in respiration. Thus it is found that in these air breathing fish the gills function essentially as excretors of carbondioxide and the air-breathing organs mainly as oxygen absorbers.

The Indian species of air breathing fresh water fish can be grouped into 4 types according to the development of the air breathing organ. In the first type which includes such forms as *Clarias major*, *Saccobranhus fossilis*, *Anabas scandans*, *Macro podus cupanis*, *Osphramenus* and *Trichogaster* the air breathing organs arise as diverticula of the opercular cavity. In *clarias major* (3) the air chambers are outgrowths of the opercular cavity between the hyoid and the 1st branchial arch. They develop from the roof and the posterior walls, vascular tongues and on the sides a series of vascular folds. Each air chamber contains two tree-like structures growing from the upper end of the gill arches. When the fish lifts its head and gulps in air, the ceratobranchials sink backwards and downwards closing the gill clefts between them and at the same time the anterior slit between the 2nd and 3rd gill arch which is guarded by the so called 'fan' formed by the coalescence of the gill filaments opens allowing air to escape into the air chamber. When the mouth is closed, the slit between the 'fans' is also closed but when the operculum is lifted up, the posterior slit between the 3rd and 4th arch, similarly guarded by the 'fans', opens to allow the passage of air outside from the air chamber.

The accessory air-breathing organ is in the direct course of branchial circulation. The arterial supply of the organ is from the afferent branchial arches and the blood from the organ is carried by the efferent arches.

Saccobranhus fossilis (3) is similar to *Clarias* in the structure and development of the air-breathing organ in all respects, except that in *Saccobranhus* no air trees are developed and the respiratory chamber, after attaining the dimensions of that of *Clarias*, extends backwards in the form of a long tubular sac up to the middle of the tail region. The vascular tongues similar to those developed in *Clarias* are abundantly formed, but they disappear towards the posterior end of the sac. The vascular supply is identical with that in *Clarias*.

In *Anabas scandans* (3) the respiratory chambers are situated above the gills in the postero-lateral region of the head and into

these project delicate shelly plates with crenulated edges, the so called 'Labyrinthine' organs. The chamber has an epithelial wall, richly supplied with blood vessels more or less similar to the lining of the opercular cavity. The chamber communicates with the opercular cavity and the pharynx by a tubular opening between the hyoid and the 1st branchial arch. The communication with the pharynx is controlled by a valve. The labyrinthine organ is a shelf-like outgrowth from the epibranchial segment of the first branchial arch and is covered by a thin epithelium. There are two openings into the air chamber, the anterior allows the air to pass into the air chamber from the pharynx and the posterior serves for the passage of air to the exterior.

The blood supply to the organ is from the efferent arches and the purified blood is carried by the jugular vein.

In *Macropodus*, *Osphramenus*, *Trichogaster*, the structure, development and physiology of the air breathing organs are similar to those of *Anabas scandans*. (1).

In the second type, the air breathing organ arises as a diverticulum of the pharynx as found in *Ophiocephalus punctatus* and *Amphipnous cuchia*.

In *Ophiocephalus punctatus* (3) the air breathing organs are pearshaped pouches of the pharynx extending back up to the 3rd gill arch. The epithelial lining of the air chamber is richly vascular. A number of lacunae separated by thin septa of connective tissue underlie the vascular epithelium. The capillaries extend up to the surface in these septa and form terminal tufts. The passage of air into the air chambers, is through two holes on the roof of the mouth surrounded by muscles. When the mouth is open, the holes allow the air to pass into the air chamber. The air from the respiratory chamber is sent out by the contraction of the muscles surrounding the air chamber and also by the spring-like action caused by the opercles and subopercles which bound the air chamber externally. The blood supply to the respiratory organ is from the III and IV aortic arches and the blood from the organ is drained by the jugular vein.

In *Amphipnous cuchia* (3) as in *Ophiocephalus* the air chambers are outgrowths of the pharynx with which it communicates by an aperture between the hyoid and the 1st branchial arch. The fish is devoid of an air bladder and its gills are much reduced. The air sac in its distal and posterior portion gives off numerous alveoli and comes to resemble an amphibian lung. In other respects its respiratory organ is identical with that in *Ophiocephalus*. The blood supply as in *Ophiocephalus* is from III and IV aortic arches, and the blood from the organ is carried by the jugular vein.

In the third type, the branchial chamber itself functions as the air sac as is found in *Symbranchus marmoratus* (7). It has well developed gills and the gill chamber is very long opening by a single median ventral opening. The whole of this lining of the gill chamber as well as the roof and floor of the mouth are provided with a rich network of blood vessels forming a respiratory tissue. J. Muller mentioned of a certain diverticulum of the roof of the mouth which was supposed to be a respiratory organ. This was shown by Taylor (7) to be an invagination of the lining of the gill cavity, a device for increasing the area of the respiratory surface. The afferent arches supply the blood to the organ from which, the blood is carried by the efferent vessels.

In the fourth type, the respiratory organ is a development of the intestine. Intestinal respiration is found in *Lepidocephalicthys* and other genera of *Cobitidae* in which the intestinal walls are specially modified for absorption of oxygen. The air passes in through the mouth. The vascular system in these cases is remarkable. The arterial supply to the organ is from the dorsal aorta, the blood from the organ is drained by the hepatic portal vein which passes through the liver on its way to the heart.

A feature of the vascular system in most of the fishes which possess accessory respiratory organs is that the vein which carries blood from the respiratory organ also brings blood from other parts of the body, and therefore the pure blood is mixed up everywhere. The average oxygenation

is however kept up by continued addition of pure blood from the respiratory organ. Obviously this system is less efficient than the more usual condition obtained among the land vertebrates, where there is an elaborate mechanism for preventing this mixing up of pure and impure blood. The first step towards this end is the formation of a separate pulmonary vein which in higher vertebrates is followed up by the separation of heart in to a right and left half for separating pure and impure blood in the heart. From this point of view the fishes with accessory air breathing organs are only imperfectly adapted for an aerial mode of existence.

The habit of seeking oxygen from air when its supply in water fails is common among a number of teleosts. This habit is intensified in the air breathing fishes to such an extent that it has become a necessity with them. The subject of aerial respiration in fishes is of interest not only as marking a fundamental change in one of the main physiological systems of the body but as the starting point of a series of changes which made possible the escape of vertebrates from an aquatic habitat. The air breathing habit appears to have been attempted more than once in the course of evolution. The archaic fishes of the Devonian period successfully attempted air breathing by developing the lungs which survive today as the lungs in Dipnoi and its homologue the air bladder in the bony fishes. The accessory air breathing organs are the result of a later effort of the fish to breathe air. Whatever the circumstances that led to this habit, it is clear that lack of oxygen in the tropical waters and to a certain extent high temperature in the tropics are factors of importance in preserving the air breathing habit in these fishes.

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Living Batteries.

BY A. M. SAMBANDAM, M.A.

ALL the vital activities of animals result in the manifestation of various forms of energy such as Heat, Light, Electricity, etc. Whenever a physical or a chemical change takes place in the body, it is accompanied by electrical change and production of heat. The contraction of a muscle or the secretion of a gland results in a change of the E. M. F. of the organ concerned, which can be measured by a very sensitive galvanometer. It has been demonstrated by J. C. Bose that the physiological changes in the plants are always accompanied by electrical changes and that a current of rest which increases or decreases with the increase or decrease of internal energy, flows in all tissues from the less to the more excitable part.

Some kinds of fish have taken advantage of the production of electric current during the secretion of a gland or the contraction of a muscle by utilising the same for purposes of offence or defence; this is done through specialised methods of localization and concentration of the glands or the muscles. Electrical organs thus formed occur in different groups of fishes both marine and fresh water. The Torpedo¹, Hypnos² and some species of Raja among the Selachii, Gymnarchus³, Malapterurus⁴, Gymnotus⁵ and Astroscopus⁶ among the Teleostei are examples of fish possessing such organs. Among the fishes of our coast mention can be made of the rays—Narcine timlei⁷ and Astrape dipterygia⁸ which possess similar organs. The electrical organs are composed of metamorphosed muscle fibres in all the fishes mentioned above except in Malapterurus where the integument of the glandular system gives rise to such organs.

1. The electric Ray of the Indian Ocean. 2. The electric ray of Australia. 3. The electric 'eel' of the Nile and West African rivers. 4. The electric cat-fish of Tropical Africa. 5. The electric 'eel' of the fresh-waters of S. America. 6. The "star-gazer". 7, 8. The electric rays of the Indian Seas.

The localization of the electrical organs varies in different groups. In *Raja* they are placed one on each side of the terminal portion of the tail while in the *Torpedo* they occur at the sides of the head in the region between the gills and the cephalic prolongation of the pectoral fins; in *Gymnotus* the organs extend through the whole length of the tail which is nearly four-fifths of the total length of the animal; in *Astroscoptes* they lie in cavities which are outgrowths from the orbits. *Malapterurus* differs from the above in that the organ forms a sort of mantle lying just below the skin enveloping the whole length of the body and the tail.

The electrical organ of the *Torpedo* consists of hexagonal columns arranged dorso-ventrally, each column being made up of a number of discs piled one over the other like the units of a voltaic pile. A series of hollow cones fitted one inside the other take the place of the above discs in *Raja*. These discs or plates (electroplaxes) are made up each of four layers. (1) The nervous layer with large nuclei containing the termination of the nerves; (2) The compact mass of lamellae; (3) An alveolar layer and (4) A gelatinous and a granular layer serving as an insulator.

The nervous supply of the electrical organs varies in different fishes according to their location. In the *Torpedo* the innervation of the organs is effected by branches of the trigeminal and the vagus. In *Astroscoptes* the organs are supplied with nerves by a branch of one of the nerves of the muscles of the eye. The electrical nerve of *Malapterurus* proceeds from a huge mass of nerve ganglion at the anterior extremity of the spinal cord. The electrical nerves divide repeatedly and lose themselves in the nervous layer of the electrical plates or discs. The repeated branching of these nerves and their ultimate disposition in the nervous layer enable the exciting nervous impulse to produce the physiological change at the same time in all the parts.

The electrical organ in fish possesses two kinds of electricity, the organ current and shock; the former has been detected in

all living tissues; it has the same distribution as shock from which it differs only in the smallness of potential difference. Shock which is the electrical response of an organ to excitation is considered a reflex effect. It has been found that a prolonged

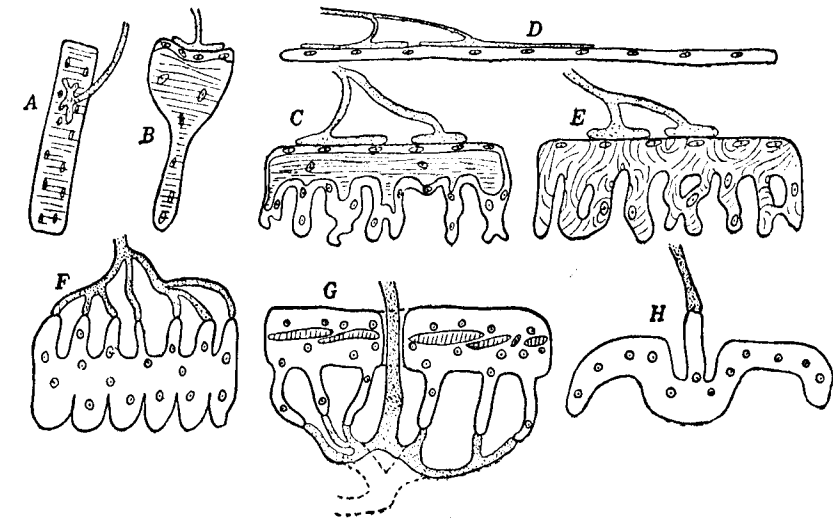


Fig. From Dahlgren and Kepner. A-H. A series of diagrams of various kinds of electroplaxes, showing in part their polarity and their relations to the striated muscle fibre. All nerve centres stippled. Striated structures indicated by lines.

A. Muscle fibre; B. Electroplax of young *Raja batis*; C. Electroplax of *Raja laevis*; D. Electroplax of *Tetronarce*; E. Electroplax of *Astroscoptes* the "Star Gazer"; F. Electroplax of *Gymnotus*, the electric "eel"; G. Electroplax of *Mormyrus*; H. Electroplax of *Malapterurus*; Innervated surface above, on all but G.

series of excitation weakens the reflex discharge and that the latter can be restored to its original intensity after an interval of rest. The E. M. F. of each electrical plate is said to increase with the physiological sequence of the impulse from the nerve. Though the induced electromotive force in each plate is small the arrangement of the plates in series enables them to acquire intensity. Thus the length of the column, the number of electrical plates that build up each column and the metabolic condition of the animal have an influence on the intensity of the shock. These account for the difference in the strength of the shocks imparted by the different kinds of electric fishes. It is of interest to note that a single stimulus in these fishes produces electrical discharge which is repeated several times in rapid

succession. This oscillatory character in the discharge is explained by the fact that while a moderate stimulus induces only a single response, a single strong stimulus induces multiple response.

As for the origin of electrical organs in fish, embryology has shown definitely that they arise through the metamorphosis of muscles. Serial sections taken at different stages during the embryonic development of the Torpedo and Raja serve as a picture guide of such a metamorphosis. The embryonic muscle fibres destined to become electrical plates assume first the form of clubs, then of plates and later undergo a process of concentration and other modifications.

Science does not throw any light at present as to how electrical organs have arisen during evolution. Why the electrical organs are developed in fishes alone among animals is not properly explained. Whether this is due to any peculiarity in the tissues of fish or whether such electro-motive reactions are not possible in other animal or plant tissues is a matter for further investigation.

Migration of Animals.

BY P. C. RAJU.

IN our country, generally very seldom do we find any definite line of demarcation between the four seasons of the year. But we are all aware of the two distinctly marked off seasons—the winter and the summer comprising of the months of October to March, and April to September respectively.

During winter, that is, from the month of October till about the end of March, Nature seems to be gay and happy with the rivers running full, plenty of grains growing and the land looking green everywhere with the sweet fragrance of the blossoming flowers.

A large number of visitors take pleasure in visiting our land during this period since it is very congenial and enjoyable. A foreign Cricket team, or any other team in the sporting field, which wants to pay a visit to our land does it invariably during our winter. Even when any Royal Commission or any Parliamentary Committee from the Home Government wants to enquire into the political, commercial or economic condition of our land they choose only this particular period for their visit. So it is no wonder that the birds too choose the right part of the year to visit us—between October and March—and thereby enhance the beauty of the land with their variegated colours. But it is really a pity our land is not gifted with a Wordsworth, or a Shelley, or a Keats though it has a Tagore.

Among the winter visitors we can easily recognise a small bird with a long beak which springs suddenly with a harsh call, out of the marshy herbage and flies high in the air with a rapid flight. It has got a dark brown plumage streaked and variegated with black rufous and buff, and the lower parts being white. This is the Common Snipe also called the Fantail snipe (*Capella gallinago*). They usually come during the month

of September and by the end of March they bid good-bye. But in Southern India they arrive later than September and leave about the month of April.

The handsome black and white Pied Wheatear which breeds in South-east Persia, Baluchistan, Afghanistan and the neighbouring areas of the N. W. Frontier province, during winter migrates to India. This Wheatear which is one of the earliest visitors arrives about the middle of August and leaves back to its home somewhere in February and March.

The Indian Tree-pipit, a bird of brown plumage with a greenish tinge and a broad yellow streak over the eye, breeds in Siberia, Northern-China, Japan and on the higher Himalayas about 7,000 ft. to 12,000 ft. In winter it migrates southwards to Southern-Japan, Southern-China and India. At that season it is found in India throughout the greater portion of the plains and southwards it extends up to the Palni Hills. During the breeding season we also find this bird getting romantic and singing melodious songs.

Another visitor is the Green winged Teal (*Nettion crecca*) also known as the Common Teal. This is the smallest and one of the most handsome and sporting of the migratory ducks. This is distinguished from other Indian species by the prominent emerald green and black speculum and the pale cinnamon bar on the coverts. It usually visits us during the month of October and stays in our land till April.

The Red-Breasted Flycatcher (*Siphia parva hyperythra*) as the name implies is one which flycatches on trees and is easily recognised by its red colour on the throat and breast. The bird generally breeds in Kashmir and spends its winter in Ceylon. It is very often observed in Southern India especially on the Nilgiris and in Travancore.

The Indian Pitta belonging to a family which is purely confined to India with no equivalent in Europe is a well built bird with a short stumpy tail. This bird is beautiful to look at

with its variegated plumage. This breeds in the north during the months of June, July and August and spends its winter in the South. In Telugu language the word *Pitta* (పిట్ట) is used to mean a small bird, and it is also an endearing term for a charming girl, so it is very probable that the word Pitta given as the name of this bird—*Pitta brachyura*—is the latinisation of the Telugu word.

During the month of October we find in many places in India a very slender and graceful duck with long neck and a sharply pointed tail. This is purely a winter visitor arriving about the month of October and leaving our land by the end of March. These are known as the Pintail (*Dafila acuta*). These are considered the best amongst the ducks of India. These are very good as sporting birds and are also good for the table.

The Red-crested Pochard (*Netta rufina*) is the biggest of all the diving ducks and is very abundant in many places in India. This is a usual winter visitor to our land from the far North during the month of October which leaves about the end of March.

In India great numbers of northern birds arrive during September and October and leave in March and April. Among the smaller birds are the Wagtails, Pipits, Larks, Warblers, Shrikes, Hoopoes, and Quails. Some species of Cranes and Storks, many Ducks and a large number of Scolopacidae also visit India in winter. These birds are almost all natives of Europe and Western Asia; they spread all over India mingling with the sedentary birds of the Oriental fauna and give to the ornithology of Hindustan at this season quite a European aspect.

This sort of movement from one place to another seems to be characteristic of many animals. In order that such a movement can be called "migratory" it must involve a definite change of locality with some purpose, and be associated with some definite advantage which serves as its *raison d'être* but it need not necessarily be of great geographical amplitude. So that true migrations are changes of habitat periodically

recurring and alternating in direction which tend to secure optimum environmental conditions at all times.

Then, what is it that necessitates this sort of movement in animals? and which is it that inculcates this spirit in them? The probable solution for it may be that it is an inherited custom which is awakened semi-annually to active expression. Forces which are insufficient as compelling causes may act as releasing stimuli or occasional causes. The sources of stimulus may be external or internal. The stimuli may arise from the seasonal changes in the physical world or they may be physiological factors arising in the cycle of alternation between reproductive and non-reproductive phases. A combination of various influences, possibly with a predominance of external factors in autumn and of internal factors in spring is suggested as a possible explanation, but the *modus operandi* of the actual performance still remains as a problem yet to be solved.

Among the birds it can be the result simply of intelligent action on the part of the birds and therefore, strictly analogous to the behaviour of human beings who, in the case of those living in the hot tropics decide to spend their summer in a bit colder part like the hill stations and in the case of those living in the colder parts—like the temperates—try to spend their winter in places of milder climate, thus to secure the optimum environmental conditions at all times.

Or it may be the direct effect of recurrent physical forces, the migrants themselves being almost passive agents submitting to compulsion; Or, it may be the expression of an inborn custom transmitted by inheritance:

There is often great mortality during migration, yet with all that, the migration is often very successful: the birds find their way to their winter-quarters and they find their way back again.

The probable question that is now confronting us and which requires explanation is, how do these birds determine their path and goal for migration? The factors determining the path and goal of the migratory birds may be all sorts of landmarks—

mountain ranges, shore line, river valleys and islands, as they are gifted with a powerful and acute vision. The social character of many migrations suggests that it may be in keeping with the tradition. Those who followed for several years may become the leaders in course of time. But there are instances where the birds leave their young ones as soon as they are hatched out and return back to their original homes; and the young ones when they are fit for the flight start much later than their parents and unerringly go back to the original homes of their parents. So it may partly be due to the cumulative inheritance of the results of experience and this can be possible according to the Lamarckian view of the inheritance of acquired characters, and lastly it may be that the birds have a high sense of direction much more than other animals and it is well known that homing-pigeons are able to return to their homes from great distances.

In fishes too we find migration taking place. Among fishes the movement may be anadromous as in the Salmon which migrate from the sea into the fresh water to spawn or Catadromous as in the Eel which leave the fresh water and go to the sea to spawn. There are certain fishes which leave the depths of the ocean and go to the shallow region for spawning, while a few others leave their shallow waters and go to the shores for spawning.

The fresh water Eels (*Anguilla*) spawn in the deep waters of the ocean. With the approach of maturity eels migrate from the fresh water down the rivers into the mid-ocean, their spawning place. The larval eel which is ribbon shaped and transparent, so transparent that only the pigmented eyes are visible is known as *Leptocephali*. The larvae drift in the ocean currents towards the coast, where they change into *elvers* and these elvers—the name given to the larval *Leptocephali* after metamorphosis—migrate up the rivers and spend many years feeding and growing until maturity impels them to return to the place of their origin.

The Salmon (*Salmo ferox*) shows an alternation between a period of reproduction in fresh water and a nutritive period in

salt water. The adults do not feed at all in fresh water and when they return to the sea after breeding, they are lean and poor conditioned "kelts". Some indeed die after spawning.

The migration of sprats and sardines when they attain maturity is really noteworthy. Spawning takes place off-shore and is followed by a denatant feeding migration in summer and autumn, after which a return migration is made and a reassembling takes place in winter in coastal water.

Turtles make periodical journeys from the open water to the land for the purpose of laying eggs in the sand of the sea-shore. The adult turtles leave the shore and when the young hatch out they find their own way unerringly to the sea.

A similar behaviour is also noticed among the various sea-snakes, which periodically come inshore to the shallow water for purposes of reproduction.

There are other movements of certain animals which do not come under migration and they are Emigration and Nomadism.

Emigration is a mass movement away from the sweet homes with no possibility of returning to the original home territory as contrasted with the phenomenon occurring in the case of migration. The one immediate cause for this movement may be complete failure of food supply or of the food of the right quality. Another cause may be overcrowding in the home territory, due to an excess of births over deaths and consequent shortage of food. A third cause may be the expulsion by force of a minority of a colony which threatens to endanger the livelihood of the rest; Or, for the same reason the forcible expulsion of the young by their parents from the home territory.

Nomadism which is a state of living a wandering life is a movement which may unquestionably be regarded as instinctive, since it is based purely on the necessity to find food for sustenance of the life of the individual, and it is essentially an alimantal movement though indirectly the climatic conditions may have its influence on it. But it is never directly concerned with reproduction and the improvement of the race.

Honey Bees & How To Tame Them.

BY G. K. RATHNASWAMY, IV. B.Sc.

Introduction.—Honey has been in use from time immemorial in India and in other parts of the world. In India it is chiefly used with medicines by native doctors who mix it with medicines to facilitate a more easy assimilation. Only some professional bee hunters in the forest know something about the habits of bees. The professional bee hunters cover their face and body and go at night to the places where the bees build the combs. They burn the bees with torches and get the combs from which honey is extracted by squeezing. The honey that they squeeze out thus, can hardly be called honey, because a large percentage of it contains 'larval juice'. The honey sold in the market at a cheap rate is something like this or even worse than this, because it is adulterated with sugar syrup. Pure honey is a viscous liquid. The colour of the honey varies according to the season in which it is extracted or the flowers from which it has been gathered by the bees. Now bee-keeping has become a very popular hobby and a cottage industry. It has been calculated that bees have to consume about twelve pounds of honey to produce one pound of wax. In the modern method of bee-keeping what is aimed at is to get the purest honey without destroying the combs.

Different Varieties of Bees.—There are four varieties of bees in India. They are *Apis dorsetta*, *A. florea*, *A. indica* and *melliponia*.

Apis dorsetta are the Rock bees and they build a single large comb in the caves or on trees. These are the biggest of the four varieties. It is not possible to tame them because they are very ferocious and their sting is very painful, at times proving fatal.

Apis florea build a single comb on the branches of margosa and other trees. The peculiar habit of these bees is that they store honey for sometime and then consume all that has been stored after which they swarm away leaving the empty comb behind. Since they swarm away soon and the quantity of honey gathered is not much it is not profitable to tame these bees.

Apis indica build a number of parallel combs in the hollow trunks or in the spaces enclosed by stones. They always prefer a dark place and they also take care to build their combs in places where the entrance is narrow so that other animals may not disturb them. This variety also swarms, but it does so only twice in a year. Even when there is a swarm, a colony is left behind in the old place. This is of great advantage and is best suited for taming.

The fourth variety, *Melliponia* are small bees, about the size of a young fly and these build their combs inside small holes between stones. The honey that is produced by these bees is very sweet and highly medicinal. These bees can also be tamed.

Different kinds of Individuals in a Colony.—There are three kinds, viz., the Queen, the Workers and the Drones. There is only one queen in a colony and a number of workers and drones are found. The queen is the biggest individual in the colony and it has got a pointed abdomen. The queen is provided with a sting which she uses only during royal combat. The workers are small with a pointed abdomen with a sting at the posterior end. These are immature females. The drones are slightly bigger than the workers, dark in colour and have a blunt abdomen without a sting. These are the males and their business is only to mate with the queen. The queen gets mated only once in her life time and after that she goes on laying eggs. The queen during mating, stores the sperm of the drone with which she mates.

Life History.—The queen lays two kinds of eggs, the fertilised eggs and the unfertilised eggs. The unfertilised eggs develop into drones and the fertilised eggs develop into workers

and queens. The workers produce wax for building combs and gather pollen and honey. After the queen is mated the drones are usually driven out of the colony. The workers also lay eggs which develop into drones only. The eggs are not regular and compact, and a number of them is laid in each cell. The workers lay eggs in an irregular manner, while the queen lays eggs in a compact and regular manner and only one egg is laid in a cell. In the former case when number of eggs are laid in a cell and when these develop into larvae, all excepting one are thrown out by the workers.

The eggs hatch into small larvae in about three days time. The drone larvae are fed with pollen and honey by the workers. The worker larvae are fed with honey and occasionally with 'royal jelly', a secretion from the brain of workers. The worker larvae which develop into queens are fed exclusively with royal jelly. If the queen in a colony dies, the workers build queen cells which are large, conical and usually found at the bottom of the combs and rear in them worker larvae that are fed with royal jelly. The queen throughout her life-time is fed with royal jelly. After a period of six days the larvae pass into pupal stage and at this time the entrance of the cells are sealed with a mixture of pollen and honey by the workers. The sealing is porous and allows ingress of air for respiration. The drone cells are sealed with a slight projection, the worker cells are sealed flat and the queen cells are large and prominent. Six or seven days after the sealing, the queen emerges out. The drones take about fifteen days while the workers take ten days to emerge out. The sealing is devoured and the insects emerge with the head foremost. For a day or two they do not fly as their wing muscles are not strong. The average life of a queen is about two years, while the workers and drones live for about three months only.

Sting of the Bee.—The sting of the bee has at its proximal end a poison gland and a sac. When it stings a poisonous fluid is injected which irritates and sometimes causes much swelling. The bee often leaves the sting in our body, the sting

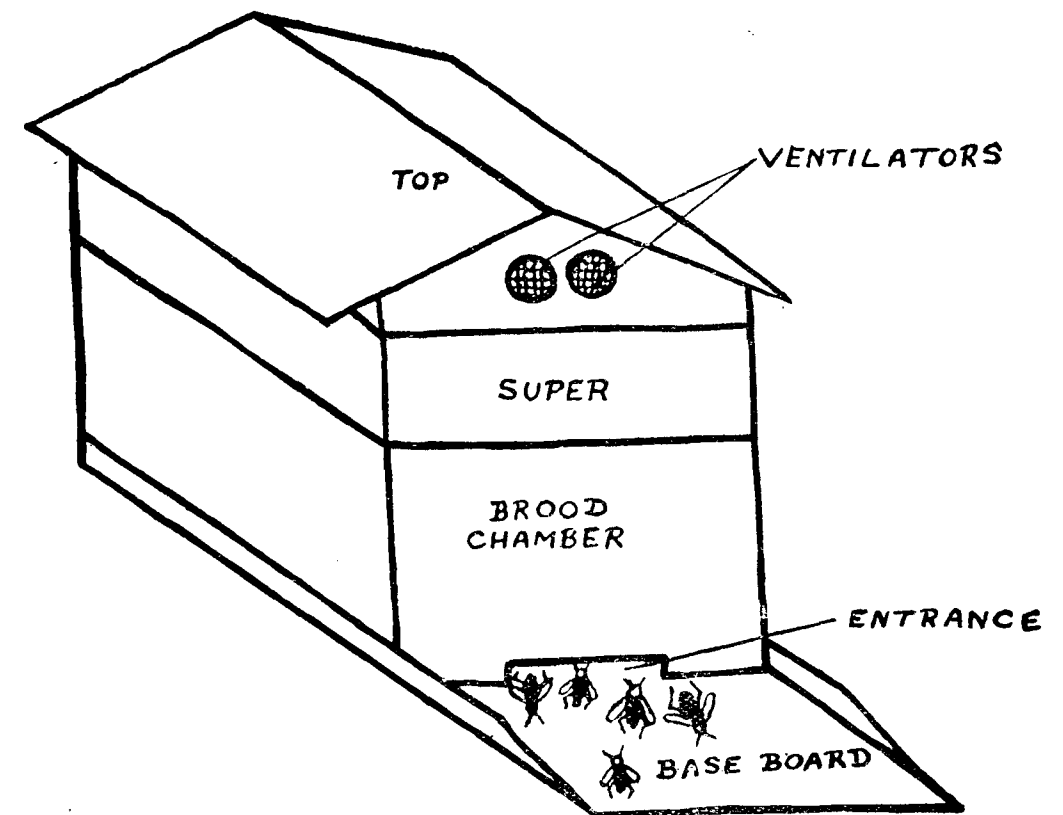
goes on injecting poison into our body and so it is always better to remove the sting as early as possible without breaking it. The injected fluid contains formic acid which emits a pleasant odour and this attracts other bees to come and sting. The formic acid injected might incidentally serve as an antidote to rheumatism.

Swarming of the Bees.—Before a swarm takes place, a number of queen cells is constructed and the queen lays eggs in them. They hatch into larvae and are fed properly by the workers with royal jelly. When a larva passes into the pupal stage, the cell is sealed. After this the queen flies away with nearly half the population of the colony, consisting chiefly of workers and settles on the branch of the nearest tree with workers crowding around it. Some workers called the 'scouts' go in search of a new place and when they find a good place, the queen with the workers goes there and begins a new colony.

The bees that are left in the original place nurse the larvae. The first queen that emerges out goes and destroys the other queen cells so that it can have the sole right. If two queens emerge out at the same time, they fight and the stronger survives and becomes the queen of the colony. If the colony is densely populated even after the first swarm, the queen which emerges out first goes away with some of the workers and begins a new colony. This is called the 'after swarm'. In the 'after swarm' a number of drones also go with the queen, so that it may be mated. If there is no 'after swarm', the newly emerged queen destroys the other queen cells, and creeps about taking honey and royal jelly. After two or three days the queen goes on her "Nuptial Flight", followed by a number of drones. The queen is a very fast flier and the drone which flies fastest has the fortune of mating with the queen and at the same time the misfortune of dying, because the drone leaves its vital organ (penis) with the queen. After the queen is mated it comes to its original place and never goes out again. If the queen is not well mated during the first flight, it goes on another nuptial flight; but such a thing is very rare,

A queen lays on an average about five hundred eggs in a day. When swarming is necessary, the queen lays unfertilised eggs which develop into drones for mating with the new queen. Large number of drones will be seen in a colony which is likely to issue forth a swarm.

THE BEE HIVE.



The Reasons for Swarming are: (1) Over population in the colony and want of space. (2) Old age and consequent sterility of the queen in a colony. (3) Over production of royal jelly. If the workers produce an enormous quantity of royal jelly, they have a tendency to build queen cells and thus facilitate swarming. (4) Over production of nurse bees. The appearance of a large number of drones in the colony and the construction of new queen cells are symptoms of swarming.

The Bee Hive.—The modern bee hive consists of a base board, a brood chamber with frames for attachment of combs with spaces for the bees to move about. The brood chamber has a small entrance at the bottom. Above the brood chamber is the super where the bees store honey. Over the super is the top with sloping sides and provided with ventilators. The bees rear young ones in the brood chamber and store honey in the super.

The combs are made up of a large percentage of wax and a small amount of pollen. The cells of the comb are hexagonal in shape. The cells in which the drones are reared are bigger than those in which the workers are reared, while the queen cells are built on the lower edge of the comb and they are large, conical and prominent.

Hiving a colony.—The bee colonies are to be found in the hollows of trees and in spaces between stones. For hiving a colony, one has to locate a colony and its hive.

Having done this, the bees are driven out by applying smoke. Bees are afraid of smoke and when it is applied to the colony the bees fly off leaving their combs naked. The combs are then removed from their points of attachment. These are bound firmly to the frames of the hive with plantain fibres. Whenever a comb is taken out, it is well examined and scrutinised for the queen bee. If the queen bee is found it is captured in a test tube and the mouth of the test tube is covered by means of a piece of mosquito curtain cloth. The seizure of the queen makes hiving easy because all the other bees will crowd round the queen. As soon as the queen is captured, the test tube with the queen is placed on the frames and the other bees will be seen entering the hive quickly. When almost all the bees have entered and settled in the hive, the queen is released and the top of the hive is placed in its proper position. The entrance of the brood chamber is closed by means of a loose plug of cloth and then the hive can be removed to any place; but care must be taken to avoid much jerking or jolting. When the hive is taken to the desired place, the entrance is opened and after sometime the bees will begin to work busily

in their new surroundings. In most cases the queen will get into the hive due to her love for home and all the other bees will also naturally follow her. Sometimes, due to much disturbance the queen may be found amidst some cluster of bees. In such a case the cluster is brushed down gently into the hive by means of a cardboard, applying at the same time small quantity of smoke. After the colony is hived, the bee hive should be placed in a shady place being protected from sun and rain.

After the colony has been established in a good place the bees will begin to work busily. They will clean the combs that may contain some dead bees or larvae, then attach the combs to the frames after which they will cut off the plantain fibres and throw them out. One will be surprised to find how neatly they keep the hive. If a bee happens to die inside the hive, the other bees will carry it out and throw it far off.

In the initial stage the super is not necessary. The bees should not be given much space, because they require warmth for building combs. During the flowering season or honey season, the bees store honey in the upper portions of the brood and rear young ones in the lower portions. The number of bees in this season is also great and at such a time the super should be provided. The upper portion of the brood which contains honey is cut off and it is attached to the super. The remaining brood portion is attached to the brood frame by means of plantain fibres and placed in its position in the hive. The bees will repair the damages caused by cutting and will store more honey in the super combs. The super frames are all supplied with combs by cutting the honey portions of the brood or if empty combs are available, they are attached to the super. The bees store surplus quantity of honey in the super and the honey they require for their use in the brood. After they have stored plenty of honey in the super combs, they seal it with pure wax. This is the correct time for the extraction of honey.

Viviparity in Fishes.

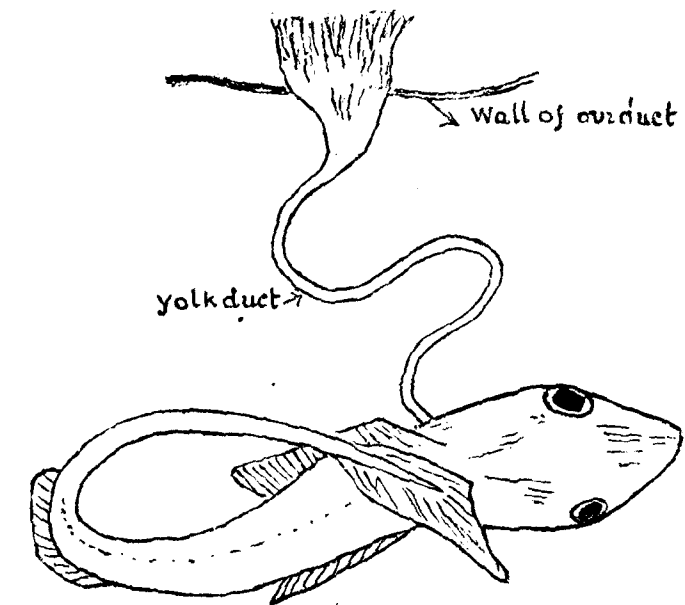
BY K. CHIDHAMBARAM, B. SC.

IN many different groups of animals, the embryonic phase of development is passed within the uterus of the mother. The advantages of this intra-uterine development are obvious for not only is the young individual sheltered to a great extent from the struggle for existence, as when it is protected within the egg-shell, but it forms for the time being, as it were, a part of the body of the adult individual with its full equipment for holding its own in the struggle. It is only in the group mammalia amongst the vertebrates, that viviparity reaches its highest development, as the final touch in their adaptation to a terrestrial mode of life but it is of great interest to note that this phenomenon occurs in a less highly elaborated form, here and there among lower vertebrates as fishes, amphibians and reptiles.

Among Elasmobranchs which comprise of dog-fish, sharks and rays, there are a large number of genera that show the intra-uterine development of the embryo. In these cases, there is a well marked tendency towards the reduction of the protective egg-shell membranes which are of no necessity. Thus there is found as a rule during early stages of development a typical set of egg-envelopes but the horny capsule is very thin and weak as compared with those of oviparous Elasmobranchs; and as development proceeds it gets reduced gradually and finally disappears as in *Rhinobatis*. A curious feature in such cases is the tendency for a group of eggs to be enclosed in a common set of envelopes instead of each having its own set. Thus in *Acanthias*, in each shell there are about 2 to 6 eggs enclosed: in *Trygonorhina* two or three, and seven or eight as reported, in *Rhinobatis*. In a specimen of *Rhinobatis* however that was dissected in the College two years back, the maximum number of eggs found in a capsule was only four. According to

Gunther also, the eggs in the capsule of *Rhinobatis* are usually four in number.

The embryo within the uterus is nourished chiefly by the yolk contained in the yolk sac. The primitive mode of nourishment of the embryo has not yet been replaced by a process of absorption from the uterine wall of the parent as is the case in the mammals. But the uterine wall in some fishes by its glandular activity has already begun to play a part, though a minor one, in providing food material for the developing young. The beginning of this is seen in the secretion of an albuminous



Embryo of *carcharias* attached to the wall of oviduct in the Yolk Sac.

fluid which is enclosed within the egg-capsule and it is possible that the elongated gill filaments of the embryo play a part in absorbing nourishment from the albuminous fluid contained in the capsule. A further development consists in the secretion of an abundant milk-like fluid which is drawn by the embryo into its pharynx through its spiracles. In accordance with its glandular activity, the lining of the uterus frequently undergoes an increase in area by the development of villi-form structures. In the sting-rays specially elongated filaments called trophone-

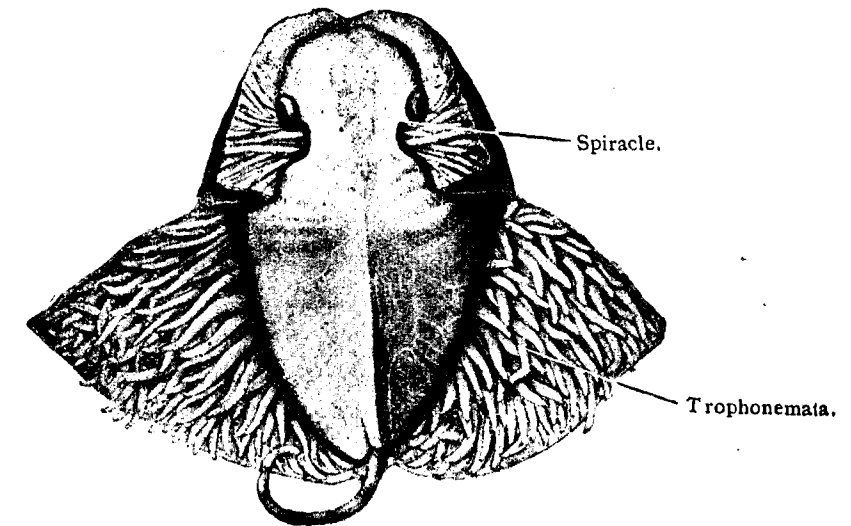
mata are developed in the uterine wall which enter into the pharyngeal cavity of the embryo through its greatly dilated spiracles, so that the secretion reaches the digestive tract of the embryo directly.

During the later stages of development there is usually an intimate relationship between the surface of the yolk sac and that of the uterine lining and in association with this, the uterine lining gets thickened and specialised to a varied extent. This may be smooth—*Squatina*, *Notidanus* or may project into longitudinal folds so as to increase the surface—*Acanthias*, *Scymnus*, *Rhinobatis*,—or grow out into trophonemata as in *Torpedo* and *Pteroplatea*. It may also develop folds which interlock with grooves on the surface of the yolk-sac, the uterine and yolk-sac surfaces being in the most intimate contact so as to constitute physiologically a definite yolk-sac placenta—*Carcharias*, *Mustelus*.

Dr. Alcock (1891) worked upon *Pteroplatea* and observed that the uterus forms a symmetrically ovoid swelling. On the ventral aspect, the mucous membrane begins to be extended in the form of short compressed papillae and these grow larger and more numerous, gradually anteriorly and laterally, until at a point in the anterolateral part of the uterus which coincides with the position of the spiracle of the embryo they form on each side a large bunch of long compressed villiform trophonemata, the histological structure of which has been worked out.

The trophonemata are narrow strap shaped processes of the uterine mucosa which widen very slightly and gradually from the base to about the middle of the length, whence they taper still more gradually to their rounded apex. Those which enter the pharyngeal cavity of the foetus are the largest of all, measuring from 18 to 20 m.m. They present a minute honey-combed appearance on their surfaces due to the presence of innumerable small depressions, which are funnel-shaped mouths, narrowing below into the lumen of the small, short bulb-shaped glands of the type seen in Lieberkuhn or in the gastric glands. The trophonemata are extremely vascular.

The spiracles are large cavities communicating freely with each other and with the pharynx and they have a lateral position and deep into them passes on each side the bunch of trophonemata in such a way that the secretion of the highly glandular trophonemata can only pass down the pharynx of the embryo. The only other external communications of the pharynx—the mouth and the gill-slits, are firmly closed. There are no branchial filaments.



Young of *Pteroplatea* undergoing development in the uterus of the mother.

A few sharks, like *Mustelus*, develop a placenta when the food yolk in the yolk-sac of the embryo is used up; folds or projections of highly vascular walls of the yolk-sac interlock with similar folds of lining membrane of the uterus and a diffusion of nutrient material takes place from the maternal blood in the uterine blood vessels to the foetal blood in the yolk-sac. Each embryo has its own placenta. This is what is seen in *Carcharias* of the Madras coast. In *Mustelus antarcticus*, the uterine projection of the oviduct is divided by septa into several chambers, each containing a single embryo.

In *Trygon bleekeri*, which was observed by Dr. Alcock during his expedition in the R. I. M. S. Investigator, the mucous

membrane was shaggy with vascular filaments dripping with milk and on examination it was found that each filament was provided with superficial muscles, whose contractions must serve to squeeze the milk out. Some such mechanism is undoubtedly necessary, seeing that the young one has no power of extracting the secretion for itself. On examination of the young one, the mother's milk was found inside the modified first pair of gill clefts or spiracles (the other gill clefts being tightly closed) and also in large clots within the spiral valve of the intestine, so that there can be no doubt that in these viviparous rays the unborn young one may be said to drink its mother's milk, like a mammal, even though the secretion does not go to the mouth but by channels homologous with the ear drum of air breathing vertebrates. All these forms are found in shallow tidal pools lying behind natural break-waters of sand, and it seemed as if this comparatively safe situation had been deliberately chosen by the mother as a nursery for her expected family, as is the case with the viviparous blenny of North Seas.

Gegenbaur (1891) writes concerning the intra-uterine arrangements for the protection of the young among selachians. He points out that the terminal division of the oviduct of the selachians which is functioning as uterus, differs from the rest of the oviduct in the nature of its mucous membrane. In many it is raised into villi and glands are well developed. Least intimate is the protection afforded to the eggs in the oviparous selachii such as *Raja* and *Scyllium*, which only furnish the egg case. In others—*Spinax*, *Acanthias*, *Seymnus*, the capsule is developed but only for a short time and the embryo then lies in the uterus.

Leydig (1891) says that in the selachians, the mucous membrane of the uterus either appears smooth and possessing only zigzag longitudinal folds—*Scyllium*, or it bears much developed villi—*Acanthias vulgaris*, *Spinax niger* and *Trygon*. These villi are placed sometimes in very regular longitudinal rows—*Rhinobatis*, *Scymnus* which cease towards the end of the uterus and pass into leaf-like longitudinal folds as in *Trygon*

pastinaca; they are so crowded together that nothing more of the rest of the mucous membrane of the uterus appears. The villi possess an exceedingly rich vascular supply.

Muller (1891) observed of the spinacoid shark—*Scymnus lichia*, that in the fresh uterus, the foetus and the yolk-sac are surrounded by a white-of-egg like fluid. There is no trace of egg-shell membrane. The foetus with its big yolk sac is 4" long and 2" thick. There are cylindrical villi of six lines in length in the mucous membrane of the uterus. In the uterine cavity, there is a little amount of fluid, generally milky, more rarely glairy and sometimes bloody, which on evaporation yields crystals of common salt, and a little animal matter composed of albumen and this Davy considered as suggesting the possibility of the uterine secretion being nutritive. He was against the view that the embryo could take the food by the mouth and held the opinion that the taking in of food is by absorption partly by the general surface of the body and partly by the branchial filaments.

Sir Everard Home in a paper on the "Mode of breeding of the ovo-viviparous shark" describes in the oviduct of *Acanthias*, the jelly that fills that part of its cavity which functions as an uterus in this animal. The young one, when completely formed, has the yolk still attached to its belly by a long cord of blood vessels and the young one in this state "swims" in the uterine jelly.

In the journal of the Asiatic society, Dr. Alcock refers to a large female of *Trygon* taken in 1888 in the Mahanadi estuary: This had the distal end of the right oviduct enlarged and it was found to contain a fully developed male foetus with a disc 11½" long and 10½" broad. The folded foetus lay free in the cavity without any structural connection with the mother and without any vestige of yolk-sac. The mucous membrane of the uterus was red and was covered by a highly albuminous fluid, secreted by a large number of glandular filaments forming the inner coat of the uterine wall. He regarded this as a "uterine milk"

secreted for the nourishment of the embryo and which was taken in by the mouth by the embryo.

Amongst the Teleostean fishes, viviparity occurs only in five families: Blenidae, Cyprinodontidae, Scorpaenidae, Comphoridae and Embiotocidae. In such Cyprinodonts as *Gambusia* and *Anableps*, the embryos are developed in the ovisacs, but as a rule both fertilization and development take place in the ovarian cavity. During a prolonged gestation, the young are nourished partly by food yolk present in the eggs and partly by a nutritive secretion derived from the ovarian walls or from the epithelial walls of the ovisacs; in *Anableps* the secretion of the walls of the ovisacs is absorbed by papillae developed on the surface of the yolk sac of the embryo along the course of the blood vessels. The eggs of Embiotocidae have little food yolk and the embryo is mainly nourished by the secretion of the ovarian walls, the secretion being swallowed and later absorbed by the villi on the inner surface of the intestine of the embryo. The number of young produced varies considerably. In Embiotocidae the ovarian cavity contains 40 to 50 young ones. The Scorpaenid, *Sebastes* of North Europe produces about 1,000 young ones while the blenny—*Zoarcus Viviparus*, produces from 200 to 300 according to the size of the female.

Among the fishes got by Dr. Alcock, during his expedition on the R. I. M. S. Investigator, was a specimen of a little ophidiid—(Embiotocidae)—*Saccogaster maculata* the female of which does not lay eggs but brings forth living young: in each ovary only the eggs of the layer that lies immediately beneath the ovarian envelopes give rise to embryos, and it seems as if all the rest of the roe were used up as food by the unborn fry. The embryos are Vermiform: They are about 1.5 m. m. in length, and are closely applied to the yolk-sac, which they embrace through a larger part of it. There is nothing improbable in this suggestion for it is well known that in the Embiotocidae, a small family of viviparous teleosts, the developing young are in part nourished by the epithelium of the mother's ovary. The fact of the viviparity of *Saccogaster* being thus established, the

genital papilla of the male can be suggested to be an organ for effecting the internal impregnation of the ova. In the female no copulatory modification of the oviduct can be made out; but the portion surrounding the genital pore is thick and spongy. The inflated condition of the abdomen and the loose imperfectly scaled skin in *S. maculata* is related to the viviparous process. The peculiar arrangement of scales, which are scattered and non-imbricating is probably one of the implications of intra-abdominal gestation: for it will facilitate increasing distension of the abdomen which must follow the growth of the embryos.

Evermann and Barton Bean during a visit to the Indian river of Florida in 1896, were convinced that the sea catfish—*Galeichthys felis* is ovo-viviparous.

Males of *Galeichthys* or *Hexanematichthys* carry eggs within their mouths. The south Indian cat fish—*Arius jella*—also shows such a ovo-viviparous condition. The female brings forth about 30 to 40 young ones which are shared by three or four males. The males carry the young ones in their mouths and during this period, the males actually starve without taking any food. Another fish—*Apogon*—showed a similar condition. The mouth and Pharynx of this fish are filled with the eggs and when this fish was caught,—during an instructional tour of the students of the department two years back at Tuticorin,—the fish tried to regurgitate the eggs.

The largest fresh water fish of Guiana, is, according to R. H. Schonbough, remarkable in that the young of the lanlan are excluded from the ovarium into the abdomen, in which state they might be like the yolk of an egg in which the small eyes, mouth and fins can be observed: and when the young are excluded, they swim in large shoals over the head of the mother. In case of danger, the mother opens her mouth and the fry find a safe retreat in the thorax.

The viviparous condition is taken up only by stray forms of the various groups of fishes and this is only a high degree

of parental care, shown by them. The viviparous forms probably have little amount of yolk in their eggs and hence they produce only a small number of eggs and they look after them till the young ones are sufficiently developed as to look after themselves: in some forms the amount of yolk is so little that the young ones have to be nourished by special secretions of the uterine wall of the mother, when the little amount of yolk present in the egg has been absorbed by the developing young during its early phases of development.

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Evolution of Parental Care in Fishes.

BY C. P. GOVINDAN NAIR, B.A.

IT is a matter of astonishment to note that Nature is methodical and has chalked-out programmes for realising her intentions. To all outward appearances it might seem as though she is an ill-managed house-hold. But the moment the cloak is removed and a dive into her depths taken, we find a vivid revelation of her foresight and economy. There is an orderly progress or evolution revealed by several phenomena of which the present article deals with one.

The gradual development of the care of the eggs and young ones among fishes, forms a very interesting subject of study. More so would be the evolutionary progress of parental care shown by the fishes. In the primitive fishes we do not find any attention bestowed on the eggs. They are allowed to be drifted away at the mercy of their aquatic surroundings. In some of the Herrings and Eels we come across this stage where protection is almost nil. They lay their eggs and with it their duty ends. But a slight deviation for the better is seen in some fresh water fishes like Salmon and Trout where we find the eggs being deposited in a depression on the ground and the male guarding over them.

In the case of the lung fish (Dipnoi), for example in protop-terus, we find the male of the species choosing an oval shaped hole filled with water adjoining its habitat. The female lays its eggs there and the male keeps a dragon-watch over them. Here there is a remarkable phenomenon of aeration of eggs noticed. The necessary oxygen is supplied by the lashing movements of the tail which set up currents in the water.

This phenomenon is better developed in other fishes. We see in lepidosiren the male of the species developing on its hind-limbs blood-red filaments which are extremely vascular.

It might be that the eggs could absorb oxygen from these filaments that are in close contact with them or that there is effusion of oxygen into the surrounding water in which the eggs are laid (Cunningham). A curious feature is presented by the lump-sucker, (*Cyclopterus*) which keeps watch over its eggs and also supplies it with oxygen. On the mass of eggs there are depressions into which the male thrusts its head and blows out water which serves as an efficient aerating process.

Another example which exhibits a tender love for the eggs is afforded by the butter fish, (*Centronotus*) which rolls itself on the egg masses and keeps watch over them. It never leaves the eggs till they are hatched though it suffers heavily during this period of fasting. Such sacrifices on the part of the parents is indeed instructive and interesting. Standing as they are in the lowest scale of evolution they still show their untainted attachment towards their young ones.

An advance over this is made by the fishes which have the power of building nests. That this is a definite advance is supported by the fact that there is a varying degree of craftsmanship used in the construction of nests. A good example of this is provided by the Bowfin (*Amia*)—a living fossil. In an article in *Nature* of September 1937, by H. Revell Whitridge on "The American Bowfin—a living fossil", a detailed account of this curious fish is given. The female of *Amia* during breeding season leaves the deep-waters and migrates into the shallows. "The Bowfin prefers a reedy place where the nest is made and the eggs are deposited. The nest is guarded by the male which is smaller than the female No particular effort seems to be made by the guardian fish to hide either itself or the nest. But the male takes care of young ones when they are herded together and thus protects them from natural enemies." (Dr. Bashford Dean).

Many of the tropical fishes are endowed with this power of nest-building. In *Amieurus*, both the male and the female take part in building the nest in the mud. It takes from

two to three days for the completion and on hatching the males are said to guard them as well as lead them. Other fishes, like *Callichthys*, *Hoplosternum*, *Doras*, and the sun-fishes, like *Eupomotis* and *Lepomus* are said to build nests, in varied architectural designs. In the former case both the sexes co-operate and make a nest of grass and cover their eggs most carefully.

The highest level of craftsmanship in nest-building is reached by the stickle-back (*Gastrosteus*). The male builds a nest of sea-weeds by carefully weaving them together. This is secured by means of thread-like material, which is secreted by the kidneys of the male. E. E. Prince has well described this unique feature of the stickle-backs. While engaged in nest-building it is so much engrossed that it rests only after its completion. When the eggs are laid the female is driven out and the males take sole charge of them.

Another fish that constructs nests is the Gourami (*Osphromenus*). This builds a nest of reeds buoyed up by means of air-bubbles that it blows into it and keeps a careful watch over the eggs. This fish is a native of China and it is recently introduced to India where it is thriving very well. The fish with its wonderful nest is exhibited in the Madras Aquarium and we can only admire the masterly way in which the nest is executed. That the fish is pugnacious needs no explanation to those who have had the chance of seeing it in the Aquarium tank. More so should it be at the time of spawning.

A common South Indian fresh water fish that adopts nest-building is the mural (*ophiocephalus*). About the habits of this P.E.P. Deraniyagala says. "They are nest building fishes, clearing a spale in shallow water where the eggs are laid. The eggs float at the surface and possess a single large oil globule. The parents guard the eggs and fry. They are predaceous in their feeding habits and are only found in fresh water and are said to take no food when guarding the eggs."

He mentions the characters of *O. marulins* and says that it builds a nest by biting of pieces of weeds, thus guarding the eggs and fry. It is even noted in one case how a parent fish leaped out of water after a marauding king-fisher. "The *O. striatus* of Mysore is said to construct a nest with its tail, among the vegetation near the edges of tanks whilst it bites off the ends of the weeds which grow in the water." Both parents are supposed to guard the eggs.

It might have been felt that the protection offered by nest was not sufficient and hence it was that some fishes took to a different mode of parental care. With all the ingenuity and craftsmanship in nest-building, the ravages from enemies could not be checked and this led some of them to adopt the curious phenomenon of buccal incubation. Arius is a well-known example of this. This is anadromous and is found to spawn at the mouth of the river Cooum. As soon as the eggs are laid, they are taken into the mouth by as many as three or four males and there allowed to develop. Here we also come across a remarkable division of labour. The eggs laid by a single female could not be taken charge of by one male and so we find three or four males sharing them. During this period the fish swims in water in an erect posture, fasts for many days and loses much of its energy. Boake rightly remarks, "Before the period of oviposition both males and females in India are said to be so fat that the curry made with them resembles that made with Pork. But after swimming about for a few days with their mouths full of eggs the males become dry and insipid".

In one *Cichlid* (*Tilapia*) we come across the same phenomenon. But here the tables are turned, the females taking the eggs into her mouth and incubating them till they are hatched. The most peculiar part of it is that when any danger threatens, the young ones rush into the mouth of the mother seeking their proud shelter. *Geophagus* also shelters the young ones by taking them into its mouth. In this case the young ones are seen to hide in the branchial recesses.

Apogon is a marine fish which exhibits the phenomenon of oral gestation. This is found at Tuticorin and two years ago a batch of students who were on an excursion to that place were able to collect one with the mouth full of eggs. One peculiar fact here is that the eggs are minute and innumerable, attached together to form a cluster or bunch. In all cases of oral gestation we find only such a number of eggs that could comfortably develop within the month. But it is curious how this small fish manages to hatch such a large number in its mouth.

This phenomenon of buccal incubation has been variously interpreted. Some hold the view that the fish might have carried the eggs to a place of safety at first and later came to retain them in its mouth. Others with equal force opine that the eggs are only the survivors of those that were taken into the mouth for feeding purposes. This view could easily be dismissed as unsatisfactory. A third view is based on the respiratory needs of the developing eggs. The pharynx is the ideal place for a constant supply of fresh-water and so it might be that they chose that place. "The interior of the mouth is capacious and the oral cavity separated from the stomach by the oesophagus which exercises the function of a sphincter and confines the eggs and fry to the cavity." Thus the eggs are always in the vicinity of fresh supply of water in order to undergo their development.

An advance over this method is seen in the development of eggs attached to the ventral wall of the abdomen,—Ex. *Nephrophis*. It might be that they adopted this in order to remove the excessive demands in the fish of buccal incubation. This paved the way for a greater advance, namely, the development of a marsupium on the ventral side, where the eggs could be brooded and carefully nursed. The sea-horse (*Hippocampus*) is the best example, where we find a great development of the marsupial pouch. In *Syngnathus*, there is a ventral pouch into which the female lays its eggs and which is closed by means of a secretion. In *Ichthyocampus* found near Pamban, the same phenomenon is noticed. The parent fish need no longer starve

as in the case of buccal incubation. In course of time, this provision was found insufficient for the needs and this led to the origin of viviparous forms in which the eggs were stored inside the body, where they underwent the early development to come out as full-fledged ones.

It seems true, when Theodore Gill says, "Probably few naturalists or psychologists will be prepared to concede the possession of a sentiment of anti-selfish altruisms by any of these lowly forms. The attribute of parental care must therefore be regarded as an outcome of selfishness or if you will self-love, a result of the sense of proprietorship." The examples cited above show a varying degree of attachment of the parents to the young ones and it could be explained only in terms of their self-love "It is the basis of the courage of the far-seeing martyr for his religion, for he is willing to sacrifice the present for an illimitable future."

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The Nutritional Theory of Evolution.

BY K. E. GEORGE, B.A.

IT is a well known fact that natural selection is one of the main causes of evolution. But when Huxley pointed out to Darwin the lack of experimental proof for his theory of natural selection, Darwin is said to have remarked "if I must think that external conditions produce little effect, what the devil determines each particular variation?" Since then, however, much experimental work has been done on the lines demanded by Huxley. Mendel did splendid breeding experiments on sweet peas which led him to the formulation of his famous "Laws of Heredity". Morgan, the Nobel prize winner, also contributed much to this branch of biology through his experiments on fruit fly (*Drosophila*). His producing new species and monstrosities of *Drosophila* by subjecting the eggs of *Drosophila* to X-rays and his elaboration of the theory of gene are outstanding contributions in recent lines to the study of evolution. Nevertheless the mechanism of evolution is as dark and vague as ever. There is still scope for theorizing and there have been no dearth of theories.

W. P. Pycraft, a distinguished British naturalist, in one of his papers, published in the *Smithsonian Report* holds that evolution occurred through use of organs in conjunction with the Darwinian scheme of natural selection and Lamarckian connection of adaptation to environment. Neither Darwin nor Lamarck explain the enormous diversity of living things. Pycraft holds that the body is moulded by the diversion of food to those organs which are most stimulated by ordinary activities. With the result, the growth is biased, meaning that the favoured organs develop at the expense of others.

"We are to regard the various types of animals as self-regulating organisms moulded by the effects of persistent stimuli sustained by their several organs or parts of organs, which thus become shaped for use in the higher animals under the controlling agency of sympathetic nervous system. But in as much as living tissue in no two organisms is precisely

alike in its qualities it follows that this 'use' will manifest itself in different ways. The tissues which are used most will take up most of what we call 'food material' growth being determined by the measure of use. But in this process of growth, in course of time, the form of the whole body may become materially changed."

Pycraft discusses the value of the germplasm theory of Weismann in this connection. Pycraft does not believe in plasm-distinction. He finds it impossible to draw a hard and fast line between germ and somatoplasms. As for example the unicellular creature like amoeba reproduces by fission and all its body protoplasm takes part in this process. He reasons "If we say amoeba is composed solely of germplasm or somatoplasm, we are making a distinction without a difference. But if the substance which forms the body of the protozoan can reproduce other like bodies indefinitely we need ask no more".

The question is still complicated by the case with which many plants reproduce either by seeds or by grafts and rooting-slips. Nobody has ever maintained that slips contain any germplasm. Yet a slipped plant which has no transmitted germplasm possesses all the characters of its race and will bear seeds. Pycraft throws overboard the accepted theory that somatoplasm is derived from the germplasm. He believes on the other hand that the germplasm has its origin in the somatoplasm. According to him somatoplasm is specialized for the purpose of transmitting characters to descendants in the course of development of the individual just as other somatoplasm, forming the brain, or ears or other parts of the body are specialized to serve definite functions.

In this connection he also attacks the Mendelian hypothesis. He admits that to the plant and animal breeder it has proved very useful, in as much as it is possible to predict what offsprings of known ancestry will be like. Undismayed he suggests "that these results would be a mingling of slightly different strains of somatoplasm."

The doctrine of descent calls upon heredity to explain resemblances in related species. But it denies the validity of the laws of heredity by allowing species to vary.

Pycraft's theory overcomes this objection by postulating the diversion of nourishment to favoured organs. But there are other objections especially those put forward by the Anti-Darwinians. Evolution according to Darwin and Pycraft proceed in minute steps. The sum of these steps become evident only after years. Such being the case fossils ought to present a different picture of evolution than they do. The foot-bones of horse reveal its evolution from a five toed state. There are no continuous transformations, but 'jumps' and hence it is not possible to trace the evolution by a series of stages. The same is the case with Archaeopteryx—the missing-link between reptiles and birds, which does not fill up the gap between these two widely separated classes—Reptilia and Aves.

The defenders of Darwin turn to living animals instead of to fossils. There is for instance the manifest similarities between legs for walking and wings for flying. It is no accident that the bones of the feet and those of the wings are the same in number and general design despite the degeneration of development of toes and the like. So we have to assume that specialized organs have somehow developed from a common fundamental type.

Embryology provides still other examples of descent. The normal number of teeth on the upper jaw of the embryo-calf disappear at birth. Some snakes have rudimentary legs in the embryo stage. If we admit that organisms are variable, we almost agree with Pycraft. If a whale, which is a mammal and not a fish, can develop from what must have been a four-footed animal everything is possible in evolution.

Professor Pycraft's mechanism will explain some of these variations, although it requires much experimental tallying.

The Origin of Land Vertebrates.

BY P. I. CHAKKO, B.A.

LAND Vertebrates, which occupy an exalted position in the scale of living organisms, range from the primitive amphibians to the highest of mammals, namely, man. At the bottom of this series lie the Amphibia, the Reptiles coming next, the birds and mammals being the descendants of the latter. The lowest of the terrestrial forms that have completely freed themselves from the aquatic environment are the reptiles. Among these seymouria a group of primitive reptiles have so much in common with stegocephali a group of primitive amphibian that the two groups pass imperceptibly into one another. Thus it would be clear that the reptiles have descended from the amphibians and the problem of the origin of terrestrial vertebrates as a whole narrows down to the problem of the origin of the primitive amphibia.

Many amphibians live in water throughout life while a few being more advanced spend only the early part of their lives in water. It is but reasonable to look for the origin of the amphibians from the aquatic animals. The essentially aquatic group are the pisces. We should naturally look for the ancestors of amphibia, among the fishes. All the evidence of palaeontology, of comparative anatomy, and of embryology points in the same direction.

Fishes however resemble Amphibia in several respects that Huxley even suggested the term Ichthyopsida to include the two groups. Among the fishes it is hardly reasonable to seek for the ancestor of amphibia among modern fishes that are too specialised to undergo such complicated transformation. Let us then examine the ancestral forms of both the groups that are available as fossils.

The outstanding contribution of palaeontological data is that it explains how the walking, air-breathing tetrapod arose

from the swimming water-breathing fish without sudden alterations in structure but by a series of gradual steps, each of advantage in the struggle for existence.

The extinct group Stegocephali were the earliest amphibians which exhibited the rudiments of land adaptations namely, walking-limbs and air-breathing lungs. From the palaeontological data that is available we know that three distinct orders of this group had appeared in the carboniferous period. The labyrinthodonts have been recorded from the lower carboniferous period. Foot-prints of Thynopus have been found in the Upper Devonian of Pennsylvania. This evidently points to the fact that the amphibians had appeared in the Devonian and possibly in the Silurian times. The most primitive amphibia so far known are the Embolomeri, an extinct suborder of the labyrinthodonts, which lived in the lower carboniferous to the Permian.

Now the problem is to decide which kind of fish gave rise to the primitive Embolomeri. Since the earliest remains of tetrapods are associated with fresh-water deposits of the Devonian and carboniferous ages their ancestors should naturally be looked for among the primitive Devonian fresh water fishes like the crossopterygian ganoids and the Dipnoans.

Of these the modern Dipnoi, including the African mudfish *Protopterus*, the South American lung fish *Lepidosiren*, and the Australian *Neoceratodus* resemble amphibia so much so that one of them was regarded by its first describer as an amphibian. Some zoologists actually think that the primitive Dipnoan *Dipterus*, known from the middle Devonian period, is one of the probable ancestors of amphibia. Noble thinks that this *Dipterus*, while showing some Urodele resemblances, has distinctive characters and indications of specialisation which preclude them from the direct ancestry of amphibia. This is especially with regard to the skull which had already begun to form large tooth-plates such as are found in the modern 'lung-fishes'. In many other features of the skull, the primitive Dipnoans differ from

the tetrapod contemporaries. The apparent resemblances between the Dipnoi and the Amphibia merely depend on parallel evolution of not distantly allied forms.

This leaves only the crossopterygian ganoids for finding the tetrapod ancestor. One family of Devonian Crossopterygian ganoids, the Osteolepidae, agree so closely with the primitive Embelomerous Amphibia in important skeletal features that it is quite reasonable to believe that the first tetrapod originated from a fish very closely allied to the Osteolepidae. The primitive amphibians agree in structure more closely with the Osteolepids than with the earliest fossil Dipnoans.

One of the most obvious and fundamental difference between the terrestrial vertebrates and the aquatic ancestors is the possession of paired walking legs by the former. The origin of the pentadactyle limb or cheiropterygium from the fins or ichthyopterygium of the fish leaves a serious gap in the history of palaeontological record. It is true that accessory locomotor organs occur even in modern fishes. Thus *Periophthalmus* jumps about on mud-flat by flicking its pectoral fins. The climbing Perch, *Anabas scandens* ascends trees with the help of spines found on its gill covers. But none of these have any bearing on the acquisition of the tetrapod limb, nor is the creeping fin of *Lepidosiren* or the biserial archipterygium of *Ceratodus* in the main line of origin of tetrapod limb. Here again it is the Osteolepids that throw some valuable light as to how the cheiropterygium might have evolved. Lately Broom has drawn attention to the fact that the pectoral fin of *Sauripterus*, an Upper Devonian Osteolepid, consisting of a broad basal lobe containing several bones and of fringe-like expansion, is adapted for support and that it foreshadows the terrestrial limb of the tetrapod. The single proximal bone represents the humerus, the two distal elements represent the radius and ulna, and the dozen distal radials or some of them represent the bones of the wrist, palm and digits. Of these, certain bones have been lost and others added and the entire fin-ray portion has been lost, and a structure was obtained

not much unlike the hand or foot. This change might have been probably a single phenomenon of mutation and the rest of the evolution of the pentadactyle limb might have been gradual.

Another remarkable difference that distinguishes the terrestrial tetrapods from their aquatic ancestors is the development of lungs for aerial respiration. Fishes respire by means of their gills, but when taken out of their aquatic environment, die of suffocation. Modifications do occur in some fishes for partial air-breathing. Thus siluroids like clarias and saccobranchus have diverticula of gill pouches for aerial respiration. *Anabas scandens*, has spongy outgrowths of the gill for aerial respiration during its voluntary wanderings overland. But the most interesting adaptation for aerial respiration met with in some fishes is the modified air-bladder. The air-bladder occurs in practically all bony fishes. While it exhibits variations in structure it essentially consists of a thin-walled air-containing sac arising as a diverticulum of the oesophagus and often communicating with it ventrally by the pneumatic duct. In modern fishes the air-bladder is hydrostatic in function. But it is the modern Dipnoi that help us really to understand how aerial respiration was substituted for aquatic respiration, although the Dipnoans may be only exhibiting parallel evolution. The lungs whether foreshadowed by the air-bladder or not had no sudden origin, but as suggested by Goethe and Spengel was probably derived from a posterior pair of gill-pouches which failed to open to the exterior.

We know little about the condition of the air-bladder in the Osteolepids. But the presence of internal nares and other facts go to show that it could not have been much unlike that seen in the primitive Dipnoans. Thus it is most reasonable to conclude that the first terrestrial vertebrate must have arisen from a fish closely allied to the Osteolepids.

Before leaving the subject it is but relevant to make a short survey of the actual history of the impelling cause that

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lead to the greatest and most dramatic event in the history of vertebrates, namely, the emergence from the old limiting aquatic environment and the subsequent adaptation to land dwelling life.

It is but natural that the ancient records of terrestrial vertebrates have been associated with freshwater deposits, for the impelling cause could exercise a greater influence in transient pools than within the limits of the sea which is so changeless that evolution within it is not stimulated.

As has been already stated the earliest fossils of tetrapods on record show that the time of emergence was the Devonian age at the latest. The geologic evidence of climatic conditions also points to the same conclusion. Barrell has also shown by his careful study of the Devonian strata that that period was a time of lagoons and lakes with cyclic changes of conditions in the bodies of water. At one period they were brackish embayments connected with the sea by irregular channels. Then in a few thousand years these would be large freshwater lakes, and in time these would be cut down into smaller bodies of water of which many might dry up. It could therefore be concluded that when the tetrapods originated the conditions were such that their ancestral fishes were forced to take to one of three courses, namely to perish or to go back to sea or to go forward and develop into terrestrial forms. Every period of drying up of the land waters must have witnessed the extinction of huge numbers of freshwater fishes. To go back meant adapting themselves more perfectly to water life and reinvading the sea which their ancestors had abandoned. Many did go back and those are the present marine bony fishes.

The other course was to go on the path of evolution to get adapted to the terrestrial habitat. This meant the overcoming of the difficulties and drought not merely by occasional gulps of air but by some new construction which would enable them to leave the water and transport themselves across land. Two groups went on—one the lung fishes, and the other, the ancestors

of tetrapods. The lung fishes, turned their air-bladder into very efficient lungs and could live for long periods out of water, and even hibernate in summer in a nest of mud, but walking on land in its real sense is beyond them. Such halfway advance is not of much good in the long run. But the fishes which went on further along the path of evolution colonised the land.

Thus the nature of the geological record of amphibians indicate that they evolved under climates marked by seasonal dryness, and inhabited river-plains far from the sea. The circumstances of the Devonian age were not very conducive to piscine life, but were just the conditions under which amphibians would thrive. With further increase in aridity, however, such that no seasonal return to the waters occurred to make aquatic egg-laying possible, came the restriction of the amphibia and the evolution of the reptiles. The reptiles establishing themselves on land by the loss of gill-breathing for ever, and by acquiring the embryonic envelopes (amnion and allantois) began to flourish. They attained their maximum strength in the Mesozoic era, which has been called the Age of Reptiles. The reptiles further evolved along two paths into the birds of the air and the man of the world.

Tit bits.

Amphibians are said to be the pioneers that ventured into the land from their ancestral aquatic habitat. It may be also said of them that they have contributed the first martyrs (frogs) to the science of Zoology.

* * * *

To many, the age of giant reptiles may appear to have ended with the mesozoic age. Komodo Island in the East Indies has a relic of the ancient giant reptiles in *Varanus komodoensis*. This giant lizard measures twelve feet in length and is said to have a marked dignified appearance and great muscular strength. The Governor of Dutch East Indies is taking precautions to keep them from zoologists who may want them for their museums.

* * * *

"The strength of the British army is said to depend on the cats of England". This amusive statement expresses the intricacy of the web of life, and its truth will be evident when one realizes the dependence of the army on beef for food, of oxen on clover for fodder, of the clover on humble-bees for fertilization, of the humble-bees on mice to keep them free from destruction and of the mice on their enemies the cats. Spinners who rear cats have been added as a further link in this chain.

* * * *

The Great-panda (*Ailuropoda melanolenca*) occurs only in the thick forests of Northern China. It is a classic example of an animal of small distribution and it never had a wide range. It is hoped that its interests will be safeguarded at the end of the present war.

* * * *

Nature is depicted by some as a kind Mother supplying her children with grains and beautifying the earth with flowers. On

the other hand, she is described by Darwin as grim and cruel, exercising a Spartan discipline over her children, weeding out mercilessly those who are unfit to live. She is also said to evolve new lives out of old ones, and in this jugglery she is said to put old things to new use without wastage, thus showing her skill as a good housewife. She seems to be a playful mother; she makes some of her tame children put on deceptive garbs and play tricks on the mischievous ones. She makes them feign death, or hide in obscurity for the time, or change their colour when in danger. The ways of Mother Nature are truly mysterious. All this is Maya!

The Instructional Tour.

(September, 1937.)

BY MISS. S. GALLIOT.

TO begin with, our party consisted of twenty 'Zoological Specimens', I mean in the strictest sense of the term, not that all of us had come out of a zoo. Did not some one say that man (woman included of course) was only a 'reasonable animal' and according to Scientists like Darwin our ancestors, a small minority at least, are still in cages and swinging on bars, while the greater majority enjoy the freedom of the leafy boughs and open spaces of the mighty jungles.

Well, to go back to the subject on hand, as I had already mentioned, we were twenty including our Professor (May he live long) and the two attenders. The auspicious day fixed for us to quit Madras for the intended tour was the 29th of September '37. The weather was fine and the party a merry one and every one and everything seemed bright and prosperous.

It was just the day for a real good picnic. By half past ten we were all ready and at the station. By half past eleven we were comfortably packed into our compartments and steaming away to Pamban and unknown adventures.

Our journey was a pleasant one, as pleasant as one could expect a railway journey to be. Moreover, thoughtful and responsible hands had made things smooth and easy for us. We arrived at Pamban, to be precise, at 5 A.M., on the 30th September. The end was not as good as the beginning. Pamban was a most unpretentious little station which could not even boast of a waiting room. To make matters worse, the rain came down in torrents. Meanwhile we had a wash and breakfast and settled down to wait for the rain to cease. By 7 o'clock we were on our way to the rest house. We had not gone far when once



The tour party at Rameswaram.

To face page 56.

—K. C.

more the flood gates of heaven were released and the rain came down on us with redoubled force. By the time we reached our destination we were completely drenched. It was nearly mid-day before the rains allowed us to embark in a tiny steam launch for the Krusadi Islands.

We stayed at Krusadi for about 5 days during which period the weather was rather unfavourable. But though there was not much rain, the sea was unusually rough, and boating became dangerous. Considering the many drawbacks, the collections we made were extremely good. Besides our many minor captures of molluscs and coelenterates, we were fortunate enough to find a huge beautiful blue physalia, dozens of star-fish, variously coloured planarians, several holothurians and an octopus. At night by the aid of powerful petromax lights we were able to collect quite a good number of snakes, polychaete worms, corals dead as well as alive, we found in plenty round the shores of Krusadi. By the help of a powerful water telescope we were able to note the movements in fairly big colonies of corals formed at a few feet below the surface of water.

The Honours and the Post-graduate students were given all facilities for dissections in the Krusadi laboratory and it is only to be expected that they made the most of these opportunities. One very interesting dissection that was conducted for the benefit of all was that of a turtle. It was a huge specimen of its kind and had been brought to the shore two days previous to its untimely end. The animal was extremely loathe to die. The heart continued to beat for hours after the animal was killed and its flesh removed. The rhythmic contraction of the muscles were noticeable for quite a long time. Another highly instructive dissection was that of a huge shark that had been brought ashore after a storm.

During our stay at Krusadi we did not fail to visit the many smaller neighbouring islands but while crossing over we invariably experienced strong winds and rough seas and enjoyed



At Kuntukkal point (Star-fish area).



Collection at Watchman's Bay.

battling the rough waters but perhaps the boatmen and those in responsibility did not think it a matter for sport.

Our visit to Krusadi was on the whole a very pleasant affair and our thanks are greatly due to Mr. Devadas, the Research Asst. at Krusadi for making it such.

On the 6th day we once again returned to Pamban from where we immediately proceeded to Rameswaram. It was late in the night when we arrived there and found the station and the rest house crowded with pilgrims from all parts of India, come to worship at the temple during the Dasara festival. Here however we were not able to collect many specimens. For one thing the boats were not available and for another, the time of our sojourn was such that it was more in tune with play than work. However we made a good collection of large-sized *Aplysias* and not quite a number of beautifully coloured fishes. We certainly did not miss the opportunity of looking round one of the richest and most famous of temples in Southern India. It is a massive structure and a clever piece of architecture with its wonderful delicate carvings. It is also one of the few surviving monuments of the culture, skill and power of ancient India.

Danushkodi was the next place we visited and we had only a few hours at our disposal. Danushkodi is a very small town and the only feature of importance is the pier which extends a long way into the sea. A steamer happened to be lying at anchor there on our arrival and we were taken in to see the inside of it.

The next town of importance we went to was Madura on our way to Kodaikanal. The distance between Madura and Koday was covered by car. As we climbed the steep slopes of the hills the weather was anything but favourable. Rain and mist combined and conspired to cast gloom over the land so as to render our path doubly dangerous. Even the powerful head lights of the car could not pierce the treacherous darkness to

any great distance. With the careless hopefulness of youth we forgot the dangers that surrounded us and only looked forward to the gay time awaiting us at our journey's end. It was quite dark when we arrived at "Pankajam House" our temporary home. The rain was pouring and the cold was intense but the comfort and cosiness of the interior compensated for the discomfort of the exterior.

Koday as we found it next morning was all delightful and beyond description. The rain had ceased, the mist had cleared and the sun shone brightly. Flowers bloomed everywhere, flowers of every shade, colour and variety. When standing on the hill and gazing down we could faintly distinguish the colossal grandeur and beauty of the surroundings. The clouds and mist seemed to inhabit a region far below us covering the house tops and trees with a hazy veil.

On the morning of the first day we went out specimen-hunting. We made a fairly good collection from the small streams that watered the public gardens and from the surrounding woods. In the afternoon we were taken to the monastery of the jesuits where they have a very valuable collection of skeletons, preserved animals and insects at their museum. On the 2nd day which was to be the last day of our stay at Koday, while making our collections we also had the good fortune to visit the local observatory, where we learned a great many useful things of which we were previously ignorant. The last item of our programme before we turned our back on Koday was a visit to the famous Pillar rocks. Our way lay through a miniature forest studded with slippery moss-covered rocks. To go down the hill they say is easier than climb up but in this case it was just the reverse. Slowly and carefully we climbed down till we came to a small open clearance from where we could see distinctly the Pillar rocks. To all appearances these rocks look as if they had been crudely carved out in the form of pillars by the human efforts of some ancient giant cave dwellers. It was a sight worth the trouble and the fatigue. The way to the pillars formed also a good ground for collection.

In the afternoon of the same day we packed up our kit and our pleasant memories and returned by car to Kodaikanal Road Station from where we took train to Madras.

Our excursion terminated happily except for one little misfortune. One of the lady students while at Krusadi met with a slight accident. Professor Ramanathan who was in charge of the tourist party procured for her the best medical attention available at the various places we camped.

We hope it will not be out of place here to tender a hearty vote of thanks to Prof. Ramanathan for the valuable instruction and the care and kindness he bestowed on us during the time he acted the good shepherd to his little flock of students.

Synopsis of our Instructional Tours*

1936-'37

Prof. S. G. M. Ramanujam, took the final year Hons. and Post-graduates for the annual long tour on the 9th September 1936. We started on the 9th evening by the Malabar Express and the next day after-noon, reached our destination—Nilambur. We stayed there for three days and we did our collection mainly from the Nilambur Reserve Forests. On the 4th day afternoon the party started for Tannur where an interesting collection of crabs and fishes was made. The Inspector of Fisheries was kind enough to explain to us the various processes of 'fish-curing' and demonstrated to us the extraction of 'Sardine-Oil' whose food value is considered equal to that of 'Cod-liver-oil'. The next day found us at West-Hill, where we had good plankton collection and the sight of the 'sea-pens' being left ashore by receding waves in large numbers. After working through the Fisheries' collection of local specimens, we left for Chalayam, where we visited the Fish Canning Factory. Tellicherry was reached on the 16th evening where a good collection of Sea-anemones, limpets, *Mytilus* etc., was made. Here was noticed the peculiar pathological calcareous concretions in the region of the tail of the ribbon-fish *Trichiurus*. It was interesting to observe during our night collections, eels and other marine animals resting between rocks in the sea, while land animals like scorpions and centipedes came out of their hiding places in search of their prey.

The fourth year B.Sc., Students went to Courtallam, Ambasamudram, Mundanthurai, Papanasam, Tiruchendur, Kulasekarapatnam, Manapad and Tuticorin, on an instructional tour under the guidance of Mr. M. Ekambaranathan, Assistant Professor of Zoology, during the first week of January '37. The tour lasted for twelve days. An interesting collection of specimens such as—*Discognathus*, Spiny millipides, *Sponginnella*,

* We include an account of the tours of 1936-'37 as we were unable to publish it last year.

Turbinella chank etc., was made by this enthusiastic party. Our thanks are due to the officials of the Department of Fisheries at Tuticorin, who permitted us to visit the Pearl Fisheries at Periapar 18 miles off the shores of Tuticorin.

1937—'38

On the 8th February 1937 the Additional Professor took Post-Graduates and final-year pass students on a short tour to Mahabalipuram, Sadras, and Tirukkalikundram.

In September 1937, the IV and V Hons. and a few pass course students were taken by Mr. A. Ramanathan, the Additional Professor, on a long tour to the Krusadai Islands. Owing to very bad weather our collection work was hampered and the joy and thrill, of which we have heard from our Seniors, of seeing the Text-book illustrations and dead museum specimens, all alive in their variegated colours in their native haunts were denied to us, much to our regret. At Rameswaram however, the collection was encouraging. Specimens of *Aplysia*, *Mytilus*, beautifully coloured planarians, etc., were obtained. The Chank beds and other places of Zoological interest in the neighbourhood of Rameswaram were visited. From Dhanushkodi which we next visited, we went to Madura where we were the guests of the Zamindar of Chunampet for two days. Our thanks are due to him for the hospitality we enjoyed at his hands. We left Madura for the Kodai Hills, where also the collection was satisfactory. One of the places of interest we visited in the Kodai Hills was the Museum attached to the Theological Seminary at Shambaganur. In the few hours we were able to spare, we learnt much of comparative Osteology. The skeletons are arranged in a way to illustrate not only the osteology of the different groups of animals, but also to show the evolutionary aspect of the vertebrate skeleton.

We really gained much out of these tours. We are ever indebted to our Professors, for the kind treatment received at their hands.

— K. E. G.

Our Society

A general body meeting of our Society was held on the 12th July 1937 with Dr. S. G. M. Ramanujam in the chair, to elect the office-bearers for the current year (1937—'38). The following were elected at the meeting:—

President.

Prof. S. G. M. Ramanujam, M.A., Ph.D., (Lond.) F.Z.S., F.R.M.S., D.I.C.

Vice-President.

Prof. A. Ramanathan, M.A., L.T.

Hony. Treasurer.

Prof. M. Ekambaranatha Iyer, M.A., L.T.

Secretaries.

Mrs. S. V. Saraswathi.

Mr. P. S. Ananthapadbanabhan.

Representatives.

Hons. and Post-graduates: Mr. C. P. Govindan Nair, B.A.

IV B. Sc. (Main) ... Miss. Sumitra.

III B. Sc. (Main) ... Mr. G. Ramachandran.

IV B. Sc. (Subsidiary) ... Mr. K. Srinivasulu.

Union Society ... Mr. K. Chidambaram, B. Sc.

Editor.

Mr. K. E. George, B.A.

Associate Editor.

Miss. M. Samuel B.A.

The inaugural address of the Society was delivered on the 28th July '37 by Prof. R. Gopala Iyer M.A., M. Sc. (Liverpool), Director, Zoological Research Laboratory, Madras, on "The 50

years of Zoological Research in Madras" with the President of the Society in the chair. The lecture was interesting and instructive.

The members of the Society were "At Home" to the New Graduates of the year on Monday the 2nd of August at 4-15 p.m. in the Zoology Laboratory. Mr. G. Ramachandram proposed the toast of the New Graduates and it was responded to by Miss. G. M. Lukose and Mr. S. M. Krishnan.

On Monday the 16th of August Mr. G. K. Rathnaswami, IV B. Sc. read a paper on "Honey bees and how to tame them". It was a well thought out essay. Prof. A. Ramanathan presided over the meeting.

On the 25th of August Mr. K. Chidambaram, B. Sc. read a paper on 'The viviparity of fishes' when Prof. M. Ekambaranathan occupied the chair. The Lecture was interesting.

We wish to convey our thanks to the speakers at these meetings.

We are glad to be informed that the New Natural Science Block will be opened on the 1st of February 1938 by His Excellency the Governor and in connection with the opening of the block there will be a Natural Science Exhibition in the first week of February 1938.

THE SECRETARIES WISH THE MEMBERS OF THE SOCIETY EVERY SUCCESS IN THE FORTH-COMING EXAMINATION.

Mrs. S. V. Saraswathi,

Mr. P. S. Ananthapadbanabhan,

Secretaries.



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New Graduates of the Year 1937

M. A.

Miss. M. Poonnen	Second Class.
„ A. Mathew	„

B. Sc. (Hons).

Miss. C. A. Kamawa ^{1 & 2}	„
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B. Sc.

Miss. G. M. Lukose ³	First Class.
„ M. R. Lakshmikantham	Second Class.

Mr. S. M. Krishnan	„
„ K. S. Viswanathan	„
„ S. Adinarayanan	„

Miss. A. Theodore	Third Class.
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„ I. Ireland	„
„ Z. Zahirudin	„

Mr. C. C. Kuriyan	„
„ S. Narayanaswamy	„
„ A. Sambandam	„

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1. Awarded the Caithness Prize of the University.
 2. Awarded the Ramunni Menon Prize of the College.
 3. Awarded the Bourne Prize of the College.