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CONTENTS

Tetraphyllidean Larvae in the Marine Copepod, *Eucalanus pseudattenuatus* Sewell, from the Madras Coast

BY (MRS.) SITA ANANTARAMAN and S. KRISHNASWAMY,
(*University Zoology Laboratory, Madras* 5).

The life-history of Tetraphyllidean Cestodes, which are parasitic exclusively in Elasmobranchs, is not yet fully known. Their plerocercoid larvae have, however, been discovered in marine invertebrates (Wardle & McLeod, 1952). Hyman (1951) lists the intermediate hosts as copepods, ctenophores, molluscs, marine fish and various other animals. The extensive literature on the plerocercoids of tetraphyllidean and trypanorhynchan cestodes occurring in marine invertebrates has been reviewed by Dollfus (1923, 1929, 1931). The present study relates to the occurrence of such larvae in the marine pelagic copepod, *Eucalanus pseudattenuatus* Sewell, encountered on the Madras Coast.

Five infected copepods of this species were collected from the Madras inshore plankton on 13th February, 1957. These infected forms appeared pinkish in colour. Each specimen harboured approximately 300 larvae, packed mainly within the body-cavity and distributed inside the appendages (Photomicr. 1). The parasites were released by gentle

Illustrations

Photomicrograph 1. A specimen of *Eucalanus pseudattenuatus* filled with Tetraphyllidean larvae.

Photomicrograph 2. A collection of Tetraphyllidean larvae released from the body-cavity of *E. pseudattenuatus*.

pressure of the cover-slip and were found to be actively moving. The shape of the larvae varied from a triangular to a circular one as a result of contractile movements (Photomicr. 2).

Most larvae were within a thin-walled cyst, 0.090 x 0.073 mm., which is easily ruptured. The larva attains a maximum size of 0.080 x 0.034 mm., and is distinguishable into an anterior suckered region and a posterior body filled with six to nine, large, refringent granules. There are four prominent suckers, each 0.03 x 0.02 mm., arranged in a transverse row immediately behind the terminal myzorhynchus or special adhesive organ, 0.02 mm., in diameter (Fig. 1).

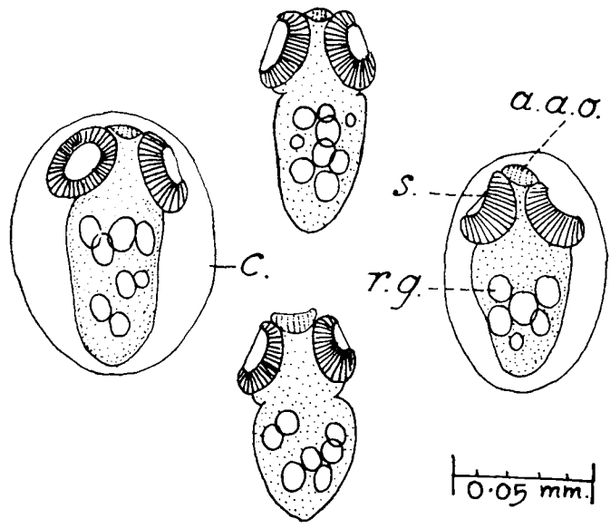

Fig 1 Camera lucida drawings of the Tetraphyllid larvae within and without the cyst. *a.a.o.* Apical adhesive organ (myzorhynchus); *c.* cyst, *r.g.* refringent granules *s.* sucker.

There was considerable evidence of 'parasitic castration' of the host, in that the ovaries of the infected females were degenerate, similar to the observations of Krishnaswamy (1950) and Sewell (1951) in the case of other infections in copepods.

Larval forms of cestodes appear to have been reported from copepods earlier by Apstein (1911) and Wundsch (1912). Jepps (1937) identified some of the larvae described by Apstein (1911) as early stages of the cestode genus *Ichthyosporidium*. She also considered a few others of Apstein's material, described separately by Wundsch (1912), as later stages of the same parasite. The epibionts and parasites of marine copepods of the Arabian Sea were monographed by Sewell (1951), in which no cestodes were included, but only protozoans and Hemiurid trematodes. An adult female of *E. pseudattenuatus* was found to be the

host only of a dinoflagellate protozoan, *Syndinium* sp. Nematode, Trematode, and Cestode parasites from *Calanus finmarchicus* were described by Marshall & Orr (1955), of which the cestode larvae were further distinguished as cyclophyllidean and tetraphyllidean.

There are two reports of Tetraphyllidean larvae from marine invertebrates of the Madras Coast, already. Krishnaswamy (1950) described 'larval helminths', of which Type A from a female copepod, *Undinula vulgaris*, is identifiable as a Tetraphyllidean larva. In describing metacercariae of an Accacoeliid from the body-cavity of the chaetognath, *Sagitta inflata*, Dollfus, Anantaraman & Nair (1954) drew attention to the presence of Tetraphyllidean larvae attached to one of the metacercariae.

Since these plerocercoids are harboured by various kinds of planktonic organisms, it is probable that they grow into adults in the Selachii, having passed through two intermediate hosts, namely, an invertebrate and a fish.

Acknowledgements

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Contributions to the Cytology of Indian Anura (Amphibia): Studies on the Spermatogenesis of Three Species of *Rana* (Ranidae)

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(Communicated by Professor R. V. SESHAIYA, F.Z.S.I.)

CONTENTS

Introduction

The great majority of the cytological studies on Anura relate only to the number and morphology of the chromosomes whereas studies on the spermatogenesis have been few. The earlier studies are those of Janssens and Willems (1909), Champy (1923), Stohler (1928) and Witschi (1924), and the recent studies are Saez *et al.*, (1936) on *Bufo arenarum*, Wickbom (1945, 1949) on a few European species, and Bole Gowda (1948) on *Uperodon systoma*. Relatively very little is known so far regarding the spermatogenesis of the Indian species of Anura. The present study is on the spermatogenesis of *Rana hexadactyla* Lesson, *R. cyanophlyctis* Schneider and *R. tigrina* Daud. The number and morphology of the chromosomes of these forms have already been described by me elsewhere (1958c).

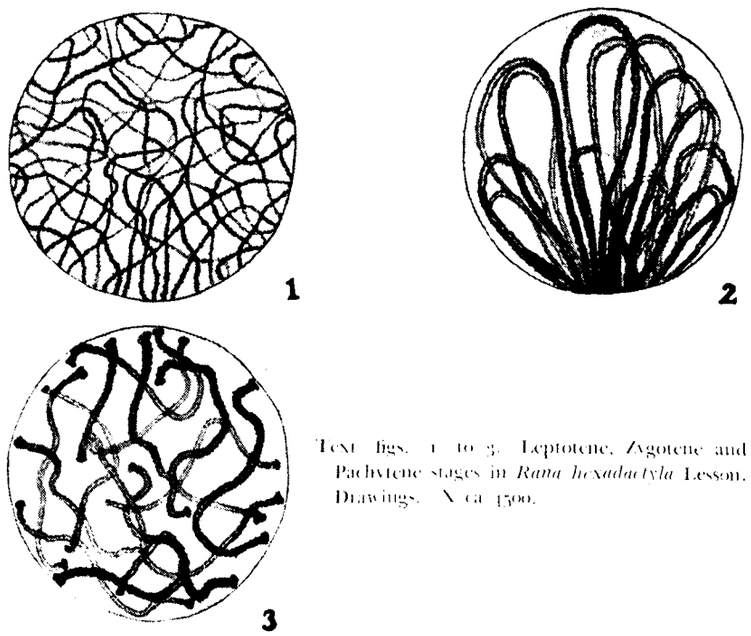
All the meiotic stages were studied mostly in Feulgen and aceto-carmine squashes supplemented by sections stained in Iron alum, Crystal violet and Feulgen.

Observations

1. *Rana hexadactyla*

I division: At the beginning of the prophase of meiosis the irregular blocks of chromatin seen in the resting nuclei gradually resolve themselves into regular threads of uniform thickness, which seem to fill up the nucleus as shown in Fig. 1. The ends of these threads appear to be attracted and crowded towards one pole of the nucleus.

The chromosomal threads, as can be made out from the figure, are slender, long and thin. No nucleolus is seen. A side-by-side union of the thin leptotene threads during zygotene results in the formation of bivalents (Fig. 2.), A more or less complete pairing and also polarisation of the threads to form a bouquet may also be noted. The granular nature of the threads at this stage is well seen in Feulgen-stained preparations. The paired pachytene threads appear much thicker and shorter than before. As shown in Fig. 3. the outlines of the bivalents are coarse and the polarisation is completely lost.

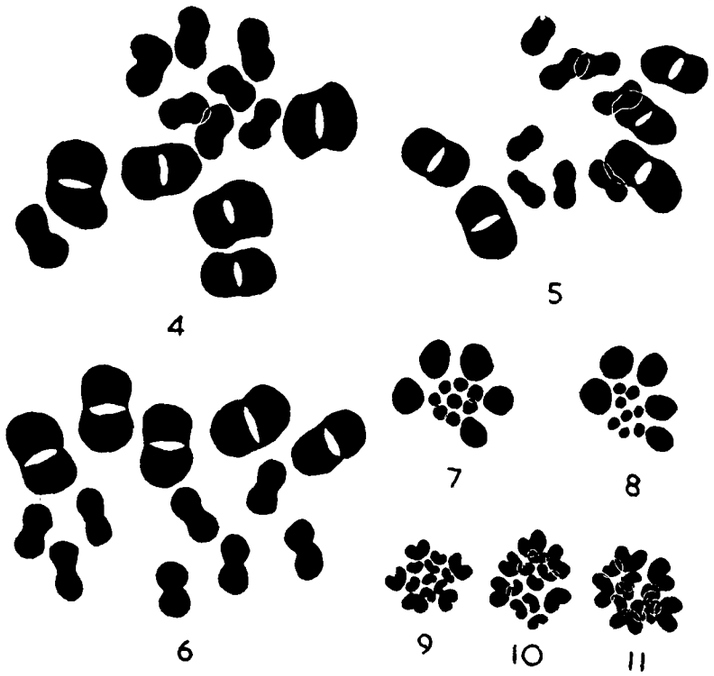


TEXT figs. 1 to 3. Leptotene, Zygotene and Pachytene stages in *Rana hexadactyla* Lesson. Drawings. X ca 1500.

At diplotene, the chiasmata are seen well formed (Photomicrograph 1) and from the time of their appearance they seem to be distributed more towards the terminal regions of the bivalents. The number of bivalents is thirteen, of which five are larger in size than the rest. Not more than three chiasmata could be seen in any bivalent, two being most common. Consequently, the calculated chiasma frequency at this stage is 2.03 (vide Table I) and the terminalisation cofficient value of 0.66 at this stage clearly indicates that more than half the number of chiasmata are terminal as indicated earlier.

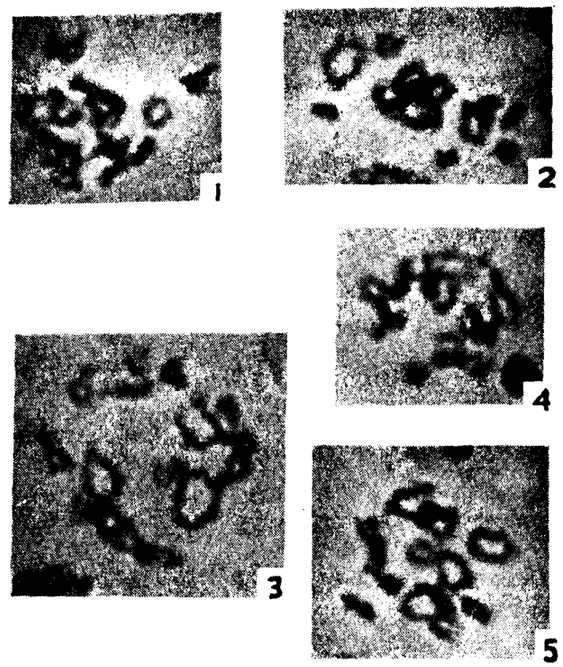
During diakinesis, there occurs a full condensation and an increase in the staining capacity of the bivalents. By late diakinesis all the bivalents become well condensed and short and deep-staining with smooth outlines. They also take up a more peripheral position, just beneath the nuclear membrane. The chiasma frequency at this stage is 1.99 and the terminalisation coefficient is 0.98 which denotes distinctly that almost all the chiasmata are terminalised at this stage. During early diakinesis, interlocking is a common feature (photomicrograph 2) between the bivalents, but during late diakinesis all the bivalents are free from one another. The larger bivalents usually appear ring-shaped whereas the smaller ones appear solid.

The disappearance of the nuclear membrane and the arrangement of the chromosomes in the equatorial region of the cell mark the metaphase stage. The bivalents have attained the maximum degree of nucleination and stain deepest, appearing simple and dumb-bell shaped



Text figs. 4 to 11. 4. I metaphase bivalents of *R. hexadactyla*—camera lucida drawing from Feulgen squash. 5. I metaphase bivalents of *R. cyanophlyctis*—camera lucida drawing from an acetocarmine squash. 6. I. metaphase bivalents of *R. tigrina* drawn from an acetocarmine squash. 7. I metaphase polar view in *R. hexadactyla*. 8. I metaphase polar view in *R. cyanophlyctis* 9. II metaphase chromosomes of *R. hexadactyla*—camera lucida drawing 10. II metaphase chromosomes of *R. cyanophlyctis* drawn from Feulgen squash. 11. II metaphase chromosomes of *R. tigrina*—camera lucida drawing from acetocarmine squash. X ca 4000.

Natarajan *Plate 1*



Photomicrographs. 1. Diplotene stage in *Rana hexadactyla*. 2. Diakinetic stage—interlocking of the bivalents could be well seen—acetocarmine squash 3. Bivalents during diplotene in *R. cyanophlyctis*—acetocarmine squash. 4. Diplotene stage in *R. tigrina*—acetocarmine squash. 5. Diakinesis Feulgen squash X ca 4000.

(Fig.4). In a polar view (Fig. 7) it may be very well seen that there are thirteen bivalents with five big and eight small elements, and the former are more towards the periphery while the latter occupy the central area. The anaphase and telophase immediately follow and take a normal course.

II division: After the telophase of the I-division the nucleus does not seem to enter into an interphase but enters immediately on the second division. The second division metaphase is shown in Fig. 9. Thirteen chromosomes could be made out clearly and five of them are larger in size. All the chromosomes appear 'V'-shaped with equal arms.

Further stages in spermatogenesis were not investigated.

2. *Rana cyanophlyctis*

The leptotene chromosomes when fully formed, are very granular, thin and tangled threads. Gradually the ends of these come to be attracted towards one pole of the nucleus. The polarisation of the threads is complete at zygotene with a typical bouquet formation. The polarisation is lost, however, during pachytene.

The chiasmata are seen fully formed at diplotene (Photomicrograph 3). The number of chiasmata is mostly two per bivalent and their distribution is mostly restricted to the distal ends of the bivalents. The chiasma frequency at this stage is 2.01. Of the thirteen bivalents, which are easily made out at this stage, five are big and the rest are small. As in the previous case, the terminalisation of the chiasmata is marked and rapid between dipotene and diakinesis. The chiasma frequency at diakinesis is 1.98 and the terminalisation coefficient value of 0.98 at this stage indicates that the terminalisation is almost complete. All the larger bivalents show enclosed space in the middle and the smaller elements are dumb-bell shaped.

The bivalents at metaphase are much condensed and short (Fig. 5). In a polar view (Fig. 8), the five larger elements may be seen surrounding the eight smaller ones in the centre.

The second division follows immediately. At metaphase, represented in Fig. 10 there are thirteen 'V'-shaped metacentric chromosomes of which five are large and eight are small.

3. *Rana tigrina*

The polarisation of the chromosomal threads which could be discerned at leptotene, becomes marked at zygotene when the chromosomes begin to pair. The paired threads are slowly condensed and the polarisation is also slowly lost. At the end of the pachytene the two components of each bivalent begin to separate from each other.

The diplotene stages give distinct pictures of the bivalents and are thus favourable for an exact analysis of the chiasma frequency and distribution. Even from the time of their appearance the chiasmata are seen distributed towards the terminal regions (Photomicrograph 4). The number of chiasmata is one per arm pair or two per bivalent. In any case the number of chiasmata is never more than three in any bivalent. The chiasma frequency is 2.03 (vide Table I). Almost all the nuclei have 3 or 4 of the bivalents interlocked and the interlocking, best seen at early diakinesis, is always proximal (Photomicrograph 5).

A marked and rapid terminalisation of the chiasmata sets in during late diplotene with the result that even at early diakinesis all the bivalents appear ring-shaped. The chiasma frequency at this stage is 1.98, and the terminalisation coefficient value of 0.99 implies that terminalisation of the chiasmata is almost complete.

At metaphase all the bivalents appear dumb-bell shaped (Fig. 6). They are thirteen in number, of which five are bigger in size than the others.

The second division follows immediately. At metaphase (Fig. 11) all the thirteen chromosomes appear 'V'-shaped with more or less equal arms. Five chromosomes are big and eight are small.

Discussion

In the present investigation, the course of meiotic divisions has been studied in three species of frogs viz., *Rana hexadactyla* Lesson, *R. cyanophlyctis* Schneider and *R. tigrina* Daud. It has been observed in all the cases that the leptotene threads are formed first and polarised later. The same condition has been reported by many authors like King (1907), Witschi (1924), Saez et al, (1936) and Bole Gowda (1948). But Seshachar (1940) and Carrick (1934) have reported a leptotene bouquet in the species which they studied. A typical bouquet was, however, seen to occur during zygotene, in all the forms included in the present investigation. Several other authors have made similar observation (Witchi, 1924; Walker, 1925; Stohler, 1928; Saez et al., 1936; Wickbom, 1945. Sato (1934) observed that there is no polarisation and bouquet formation at any stages of meiosis in *Triturus*. This is the only instance of the absence of polarisation and bouquet formation recorded so far among Amphibia.

The calcuated chiasma frequencies at different stages, as also other related data for the three species included in the present investigation, are summarised in Table I. From this it can be seen clearly that in all the forms the chiasma frequency is more or less uniform throughout with no marked variations. The number of chiasmata averages one per arm-pair or two per bivalent in all the three species.

So far, Wickbom (1945, 1949) alone has studied the diplotene stages in the different European species of Anura. He has stated that the number of chiasmata which is seen to rise rapidly to two per bivalent in the shorter arms, remains the same in the larger ones also irrespective of their arm-lengths, and as such there exists no correlation between the arm-length of the chromosomes and the number of chiasmata in Anura, in general. The present investigation, where also the number of chiasmata has been found to be the same in both the larger and smaller bivalents, leads us to the same conclusion.

Wickbom (1949) has further stated that in *Bombina* alone, among Anura, there is a correlation between arm length and the number of chiasmata, and the condition in *Alytes* presenting a very low correlation is midway between that of *Bombina* and other Anura. He says that the condition in *Bombina* may be due to the time-limit between pairing and division of the chromosomes being not restricted.

In all the forms studied by me, it has been found that the chiasmata are seen only towards the terminal regions of the chromosomes from the very time of their appearance. It thus appears that they are localised. The distal localisation of the chiasmata has been reported by Wickbom (1945) in various species of Dipnoi, Urodela and Anura. By studying the effects of temperature on chiasma frequency and by a study of heterochromatic parts of the chromosomes after cold treatment, Wickbom (1945) concluded that the chiasmata are not distributed at random but are localised distally in the species of Anura which he studied.

White (1954) is of opinion that the localisation of chiasmata must be intimately connected only with alternation of heterochromatic and euchromatic segments in the chromosomes. Callan and Montalenti (1947) have also shown that the lengths of the heterochromatic parts largely determine the mean distance between the centromere and the chiasma. A consideration of the occurrence of the heterochromatic parts in the chromosomes of Amphibia (Wickbom, 1945; Callan, 1942), which have been shown to be unusually long and lie in the main centrically where the chiasmata are not developed, leads us to the conclusion that the chiasmata are distally localised in Anura.

A marked terminalisation of the chiasmata is characteristic of all the species of Anura now studied. The terminalisation coefficient values of 0.98 — 0.99 at diakinesis show clearly that almost all the chiasmata are terminalised at this stage.

Marked and complete terminalisation of the chiasmata has previously been noted in Anura by Wickbom (1945) and Bole Gowda (1948). The former has stated that the degree of terminalisation is very high between diplotene and diakinesis but it is very slight between diakinesis and metaphase. The present investigation also shows that terminalisation is almost complete between diplotene and diakinesis.

Another interesting and constant feature in diplotene nuclei is the interlocking of bivalents in all the three species. The interlocking of bivalents at meiotic prophase has previously been observed by Schreiner (1906) in *Salamandra* and by Wickbom (1945) in many species of Anura and Urodela. Wickbom has further stated that due to the distal localisation of the chiasmata all the cases of interlocking were proximal. It must be noted here that some authors like Witschi (1924), Saez et al., (1936) and Bole Gowda (1948) have not reported any such occurrence of interlocking of bivalents during meiosis in any of the forms they have examined.

At diakinesis and also at metaphase, many authors have described one or two large 'V'-shaped or ring-shaped tetrads in various species of *Bufo* and *Rana* (Iriki, '30, '32; Makino, '32; Witschi, '33; Sato, '34; Asana and Mahabale, '41, etc.). Most of the authors considered that these 'odd chromosomes', as they called them, are connected with sex determination. According to the earlier views held by Witschi (1924, '33), Iriki (1929, '30 and '32), Sato (1934, '36 and '39) and Bushnell et al., (1936), the males in Anura were considered to possess a pair of chromosomes with differential behaviour and appearance. Witschi claimed it to be a XY pair but Iriki and Sato considered it to be a XX pair. Witschi's claims received no confirmation either from Stohler (1928) or from Wickbom (1945). The opinion of the Japanese authors was also found to be incorrect by Galgano (1933) and Wickbom (1945, '49). Wickbom has stated conclusively after a more thorough and critical study that 'in Anura and Urodela nothing has been brought to light which even suggests the occurrence of morphologically or behaviourly recognisable hetero-chromosomes in either sex.' Matthey (1949, '51) has also endorsed the same idea by stating that among Amphibia 'sex heterozygosis does not find any morphological expression.' Although gentically it has been shown by Humphrey (1942) and Ponse (1949) that in Amphibia heterozygosity exists either in the male or in the female as the case may be, we see now that this genetical heterozygosity does not show any cytologically demonstrable expression.

It has been reported elsewhere (Natarajan, 1958 a, b, c) that in the different species of *Rana*, *Bufo* and *Rhacophorus* studied, no unequal pair or pairs seem to occur among the metaphase chromosomes during somatic, spermatogonial and oogonial divisions. In the present investigation also, not even a single case of heteropycnosis or absence of pairing and chiasma formation is to be seen. Obviously we are led to the conclusion that cytologically recognisable sex chromosomes are absent in all the species included in the present study. This lends support to the views of Matthey and Wickbom mentioned above.

Summary

1. The Spermatogenesis of three species, viz., (i) *Rana hexadactyla* Lesson, (ii) *Rana cyanophlyctis* Schneider, and (iii) *Rana tigrina* Daud has been studied.

2. The meiotic divisions in all the three species follow a normal course.

3. The leptotene threads in all the forms are formed first and are polarised later.

4. A marked and complete polarisation characterises the zygotene stage. A typical bouquet and the pairing of the threads could be well seen.

5. At diplotene, the calculated chiasma frequency is low in all the three species varying from 2.01 to 2.03. The chiasmata, occurring only towards the terminal regions even from the beginning seem to be distally localised.

6. The chiasmata show a very high degree of terminalisation in all the forms and the terminalisation is more marked between diplotene and diakinesis. Terminalisation coefficient values, calculated for each species at diakinesis, vary from 0.98 to 0.99 which is highly indicative of the fact that in all the species almost all the chiasmata are terminalised at diakinesis.

7. Interlocking of bivalents, a common feature at diplotene and early diakinesis, is always of the proximal type in all the cases.

8. The metaphase bivalents are simple and dumb-bell shaped in all the species. No differential behaviour of any bivalent in any form is noted.

9. Neither heteropycnosis nor absence of chiasma formation could be observed in any of the species studied. These findings, along with the previous observations on other Anuran species support the view that sex chromosomes are not recognisable cytologically in the different species studied.

Acknowledgements

I take this opportunity to express my sincere thanks to Professor R. V. Seshaiya, Director and Professor, Marine Biological Station, Portonovo, for suggesting the problem and for valuable guidance and instruction. To the Zoological Survey of India, my thanks are due for the identification of the species. I am greatly indebted to Dr. Joseph Jacob for advice and helpful suggestions. The award of a scholarship by the Ministry of Education, Government of India, is also gratefully acknowledged.

TABLE—I

Name of the species	Diplotene					Diakinesis				
	Number of nuclei	Total number of bivalents	Chiasmata per bivalent	Total number of chiasmata	Total number of terminal chiasmata	Number of nuclei	Total number of bivalents	Chiasmata per bivalent	Total number of terminal chiasmata	Terminalisation coefficient
Rana hexadactyla	20	260	2.03	530	348	20	260	1.99	512	0.98
					0.66					
Rana cyanophlyctis	10	130	2.01	262	178	10	130	1.98	250	0.98
					0.68					
Rana tigrina	10	130	2.03	265	182	20	260	1.98	514	0.99
					0.69					

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The Anatomy of *Armandia leptocirris* Grube (Polychaeta)

BY P. R. S. TAMPI*

(Communicated by R. VELAPPAN, F.Z.S.I.)

CONTENTS

Introduction

The genus *Armandia* is one of the three genera of subfamily Polyophthalminae belonging to the Family Opheliidae (Hempelmann, 1927) and includes four known species *A. polyophthalma*, *A. cirrosa*, *A. lanceolata* and *A. leptocirris*. Of these the last two species occur in restricted localities in the Indo-Pacific region and have been collected from the Indian Ocean in the Persian Gulf, Gulf of Mannar, around the Andaman Islands and the Mergui Archipelago (Fauvel, 1932). Our knowledge regarding the anatomy of Opheliids is largely due to the early workers like Quatrefages (1850), Kükenthal (1887) and others, who have dealt with certain aspects in the anatomy of species of *Polyophthalmus* and *Ophelia*. Among the more recent papers Brown's account (1938) on the anatomy of *Ophelia cluthensis* and a similar study on *Thoracophelia mucronata* by McConnaughy and Fox (1949) are quite exhaustive. The larval development and metamorphosis in *Ophelia bicornis* by Wilson (1948 *a* and *b*) and that of *Thoracophelia mucronata* by Dales (1952), being perhaps the only detailed studies on the subject, provide several

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points of considerable interest as nothing was known until then regarding the development and settling of these larvae. Tebble's review (1953) of the genus *Ophelia* together with descriptions of some new species indicates scope for further study of the family as a whole. While we have thus some knowledge of the European forms, little information is available on the Indian species. The present account deals with the familiar Indian Genus, *Armandia* and is intended mainly to supplement our knowledge of the anatomy of the fascinating group of polychaetes, the Ophelidae, and bring out the comparison between *Armandia* and other species of the family.

This work was carried out between 1944 and 1946 at the University Zoological Laboratory, Madras, during the tenure of a research scholarship from the Madras University, and formed part of the M.Sc. thesis, but has since been brought up-to-date. This investigation was conducted under the guidance of Prof. R. Gopala Aiyar and it gives me great pleasure to thank him for his help and criticism. The author is also grateful to Dr. N. K. Panikkar for his constant encouragement and to Shri R. V. Nair for making some of the illustrations and also in arranging for the publication of this paper.

Methods

The material was collected on the sandy intertidal area on the western side of Krusadai Island in the Gulf of Mannar. These worms are capable of swift darting movement and easily disappear by burrowing themselves into the loose sand. The easiest method of collection was to dig out as quickly as possible a quantity of sand at a depth of about a few inches and lift it out of water over a basin when most of the worms wriggle out and fall into it.

Some observations made on the living worms under the binocular microscope were useful particularly in studying the course of blood circulation in the main vessels. Careful dissections were also made to study the disposition of the various internal organs.

Specimens were kept in clean sea water and in about 12 hours the gut was free of sand particles for sectioning the material. Heidenhain's Susa was found to be a satisfactory general fixative and especially useful for the musculature and the nervous system. Bouin's fluid and Bouin--Duboscq were useful in studying the alimentary canal and the associated glands. Staining was done mostly with Heidenhain's iron haematoxylin and counterstained with eosin. Mallory's aniline blue collagen stain and Hoyer's thionin were employed for the glandular elements and the blood system.

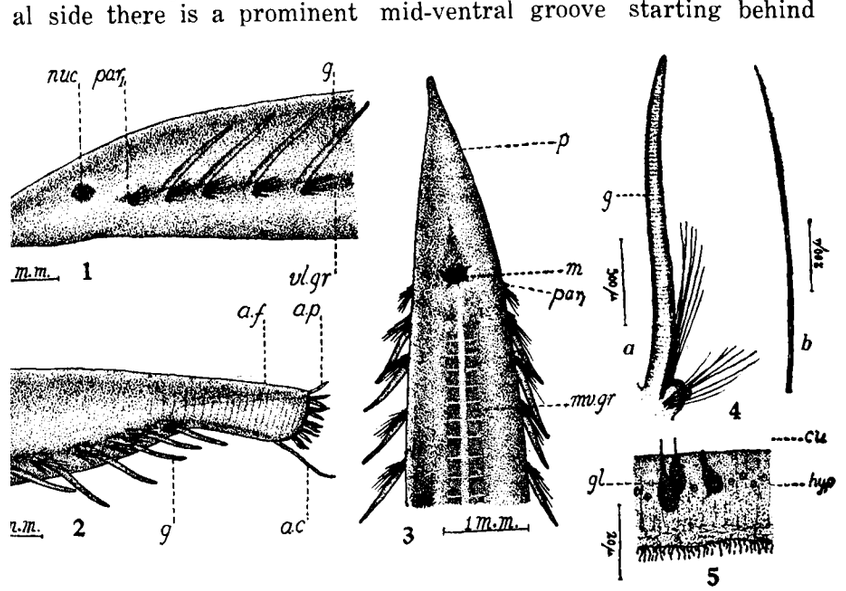
External Features

The size of the species varies approximately from 25 to 40 mm. in length and in the adult the average width of the worm ranges from 2

mm. in its broadest region. There does not seem to be any ence in size or other external characters between the sexes. In al appearance, the shape of the body roughly resembles that of *ioxus* but is more round in cross section. The segments are not ed off by annulations, the whole body being smooth throughout . 1, 2 and 3). In the present collection all the specimens possess- to 36 setigerous segments. However, Fauvel (1932) mentions that nens from Krusadai examined by him showed 36 to 38 segments those collected from Andamans had 33 or sometimes only 31 rs. Thus the species seems to show variation in the number of rs.

n freshly caught specimens the body has a light pink colour. The e is iridescent and is somewhat transparent. The species is dioe- and most of the specimens caught in February and March were lly mature Mature females could be distinguished from the males e presence of ova seen through the transparent body wall as small led structure floating in the coelomic fluid while the males appear white or slightly pinkish.

The dorsal aspect of the animal is highly arched whereas on the al side there is a prominent mid-ventral groove starting behind



nouth (Fig. 3) and reaching up to the posterior end of the animal. ddition there are two ventro-lateral grooves (Figs. 1 and 2) one on side throughout the entire length of the body beginning from the segment giving the animal a characteristic appearance in cross on with two longitudinal ventrolateral folds. The parapodia arise

from the dorsal margin of the ventro-lateral folds. They are small, each with two bundles of capillary setae. The setae of the notopodial bundle are longer and the dorsal cirri are absent (Figs. 4a and b) Branchia are simple structures and occur from the second setigerous segment up to the last one. These arise from the notopodial regions of the parapodium as simple tubular structures with close transverse annulations. Beginning from about the seventh setigerous segment are 10 to 12 pairs of what have been called lateral eye spots occurring in the middle of each segment.

The anterior pointed region immediately in front of the mouth is the prostomium or the snout which is conical in shape and highly sensitive to touch. This is a very muscular organ aiding the animal to burrow in the sand. On the dorsal side of the prostomium can be seen two or three small brown pigment spots underneath the body wall which represent the cephalic eyes of the animal.

The posterior end of the body after the region of the setigerous segments is prolonged into a long anal funnel bordered by 11 papillae and also a median jointed anal cirrus usually much longer than the papillae.

Nephridia are not visible from outside in spite of the translucent nature of the body wall; the nephridiopores are also not prominent. The nephridia may, however, be seen if the animal is slightly pressed between two slides and viewed under a binocular microscope. They appear as small greenish brown funnel-shaped structures inside the ventro-lateral folds from the 12th segment.

Internal Anatomy

Body wall and musculature: The cuticle of the snout is relatively thicker than on the rest of the body and measures about 5 micra. When examined by reflected light, the whole cuticle appears iridescent, caused by the presence of fine cross-hatched straiations on the surface. Underlying the cuticle is a single layer of hypodermal cells which do not show well defined cell walls. The nucleus is round with a darkly staining nucleolus. The hypodermis is thicker in the region of the head and the prostomium, measuring about 15 micra, and thinner in the rest of the body where it is only 10 micra high. Among the ordinary cells of the hypodermis are certain unicellular glands having an enlarged basal portion containing a nucleus and a narrow neck (Fig. 5). These glands are more numerous in the anterior region. The contents of these cells have a granular appearance and stain intensely dark with iron haematoxylin. Probably these glands secrete the mucoid substance which helps in keeping the surface of the body smooth for easy burrowing into the sand.

The circular muscle is present as a very thin layer only in the anterior portion of the snout and is considerably reduced or even absent in the middle and posterior regions of the body. These circular

muscles on the snout along with the longitudinal muscles make it a rigid organ adapted for burrowing.

The longitudinal muscles are well developed throughout the entire length of the body except in the anal funnel where they are absent. In the prostomium the longitudinal muscles occur as a continuous sheet while at the region of the brain they get divided into four distinct bundles. Of these the dorsal pair is larger and each lies on either side of the dorsal arched portion of the body. The ventral bundles are relatively smaller and they occupy the ventro-lateral folds.

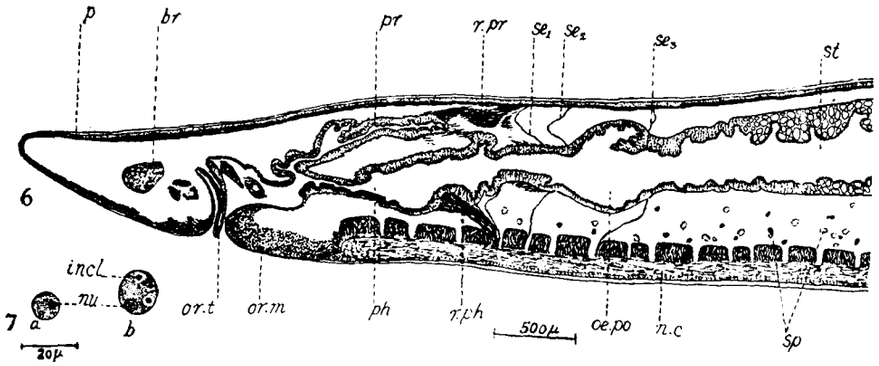
The oblique muscles are so well developed and powerful that they are responsible for the characteristic contour of the body seen in cross sections. These muscles occur in blocks or bands placed close together, the fibres stretching between the midventral and ventro-lateral grooves, forming almost a horizontal partition dividing the coelome apparently into three chambers The dorsal more spacious part contains the dorsal longitudinal muscles and the alimentary canal and the two smaller spaces inside the ventro-lateral folds enclose the ventral longitudinal muscle bundles.

The oblique muscles present a series of interesting transitional changes in the different genera of the family. In *Travisia* these muscles are thin and are not very much different from those in other polychaetes. In *Polyophthalmus* these muscles are composed of a few fibres stretching obliquely between the midventral line and the sides of the body wall. In *Armandia* the oblique muscles are relatively shorter and stouter and their enormous development results in the formation of the three longitudinal grooves of the body. The next stage in the transition is seen in *Ophelia* in which the oblique muscles, which are wide apart in front, meet in the midventral line posteriorly, push up the nerve cord and pass upward and outward as a white sheet. A still further modification is undergone in *Ammotrypane* in which the oblique muscles seem to split into two divisions, the upper much modified one passes straight across the narrowed body wall from side to side, and separates the ventral lobe containing the ventral longitudinal muscles, whilst a short but powerful strip extends from the opposite edge of the ventral longitudinal muscles to the body wall at its inner border.

There is a pair of protractor muscles attached to the inner surface of each setal sac. The retractor muscle is attached to the base of the setal sac and the ventral body wall near the nerve cord. These two sets of muscles together control the movement of the setae.

The eversible anterior part of the alimentary canal is supplied with retractor muscles attached between the ventral body wall and the floor

of the pharynx (Fig. 6, *r.pr*; *r.ph*). A series of powerful muscle fibres are attached to the lateral wall of the proboscis and the pharynx, and proceed to the body wall on either side (Figs. 9, 10 and 12, *r.ph*). The oral aperture is guarded by a ring of muscle fibres (Figs. 6 and 10, *or.m.*) forming a sphincter by the working of which the mouth is opened or closed.



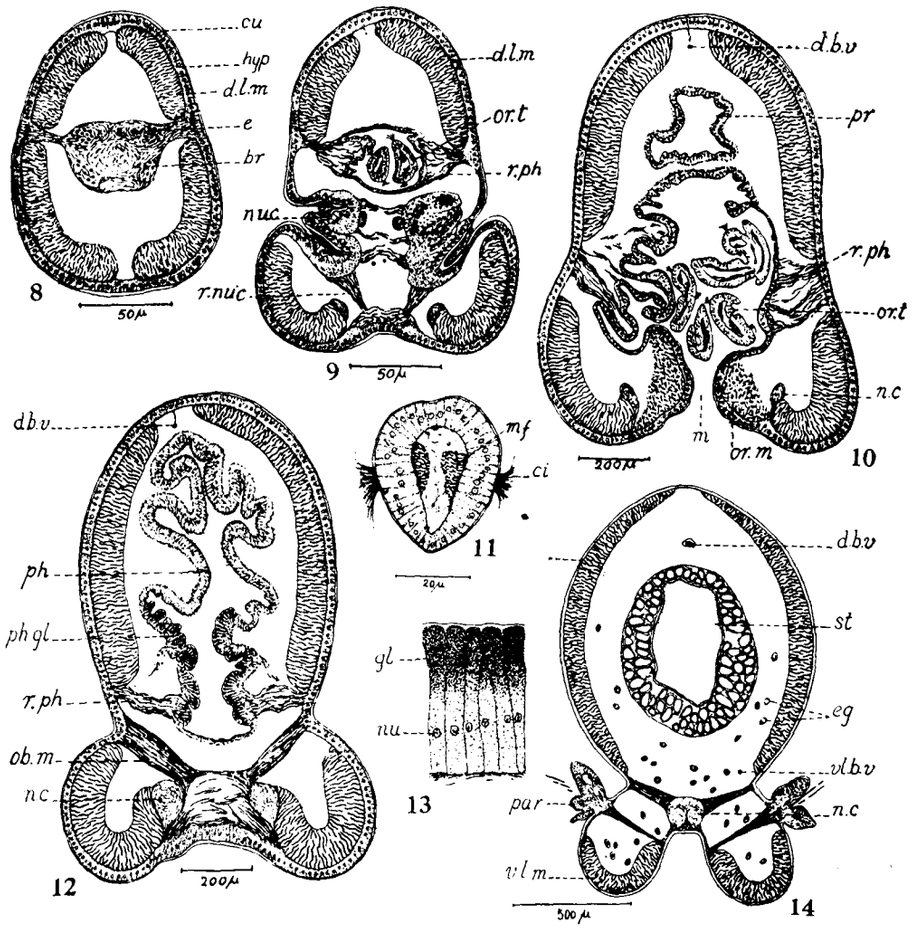
The ciliated nuchal organs which are also eversible have a set of well developed retractor muscles. These consist of about four separate bundles of which one is most prominent and is largely responsible for retracting the everted nuchal organs (Fig. 9, *r.nuc*). One end of this muscle is attached to the base of the organ and the other is anchored to the ventral body-wall on either side of the median line. The other three sets of fibres stretching between the two nuchal organs prevent their undue eversion.

Coelome: The body cavity is spacious and for the greater part it is a continuous chamber undivided by septa except in the anterior region where there are three septa at the ends of segments 2, 3 and 4. In a longitudinal section of the anterior region of the animal these septa are seen like thin vertical partitions of the coelomic cavity round the alimentary tract (Fig. 6, *se* 1, 2 and 3). The septa show no modification, unlike what is seen in certain other Opheliids. In *Ophelia cluthensis* Brown (1938) has observed that the septa which are only two and confined to the anterior region form a sort of conical caecum projecting backwards to the oesophagus, one septum being inside the other. Similar modified structures have been noticed in other Opheliids and on different occasions they have been described as a respiratory vesicle, a salivary gland, a fleshy heart, a digging organ, and an exertile funnel. However, Meyer (1882) has described the septa in *Polyophthalmus pictus* as normal structures. The presence of the peculiarly modified septa thus seems to be rather a special feature of the genus *Ophelia*.

Although it was described earlier that the oblique muscles by their enormous development tend to divide the coelome into three regions,

these three sections communicate with each other by spaces between the muscle bands. The coelomic fluid therefore flows freely into the various regions of the body cavity. It is almost colourless and contains corpuscles which may be distinguished into two types by their relative size and inclusions (Fig. 7 *a* and *b*). Both are round discoid cells. The majority of these measure about 10 micra in diameter with an almost clear cytoplasm. The other type which are fewer in number are slightly larger with an average diameter of 15 micra. Their cytoplasm is granular and the cells are often characterised by the presence of two or three small spherical inclusions of light yellowish brown colour and which stain deep with borax carmine.

Alimentary canal: The mouth is situated on the ventral side of the anterior region immediately in front of the origin of the median ventral



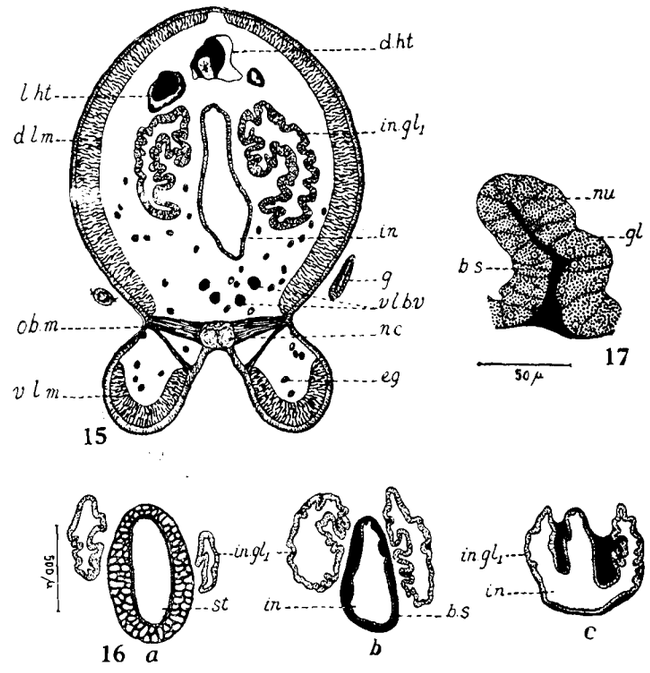
groove. In the living animal the 10 or 11 oral tentacles are intermittently protruded and retracted. Each of these oral tentacles has two longitudinal rows of cilia seen in a transverse section (Fig. 11, *ci*). Situated below these ciliary rows and beneath the hypodermis are two longitudinal bundles of muscle fibres. When the tentacles are protruded the cilia work vigorously in all the tentacles to produce a current of water near the mouth. There is also a small proboscis which is but a sacular outpushing of the roof of the mouth as can be seen in a longitudinal section in figure 6 (*pr*). In the everted condition this proboscis is not so very prominent as in most other Opheliids where it has been described as a button-shaped structure projecting from the mouth. The wall of the proboscis is made up of a layer of epithelium without any gland cells. It is also provided with a covering of muscle fibres rendering it elastic.

The mouth leads to a muscular pharynx. A transverse section through the pharyngeal region (Fig. 12) shows that the wall is composed of three regions which could be differentiated by the nature of the cells lining it. The floor of the pharynx is composed of low cuboidal cells and consequently this region is very thin. Laterally the cells are columnar and in sections appear as a darkly staining zone (Fig. 13, *ph. gl*). The cells show a glandular structure with a round basal nucleus and the cell contents are granular especially near the distal ends of the cells which stain deep blue with iron haematoxylin. Pharyngeal glands have been observed in *Polyophthalmus pictus* in which the gland cells occur in clusters and open into the pharynx by small ducts. The function of these glands in *Armandia* is not known. The dorsal half of the pharyngeal wall is thrown into a number of folds and is composed mostly of ciliated cells with clear cytoplasmic contents.

The pharynx is continued as the oesophagus. At about the 3rd body-segment a pair of lateral pouches are formed as a result of the enlargement or outpushing of the oesophageal wall. They may not be equally prominent in all the specimens and when present serve only as a receptacle in temporarily retaining food particles before they are passed on to the stomach. The cells of the oesophageal epithelium are ciliated and possess a centrally situated nucleus.

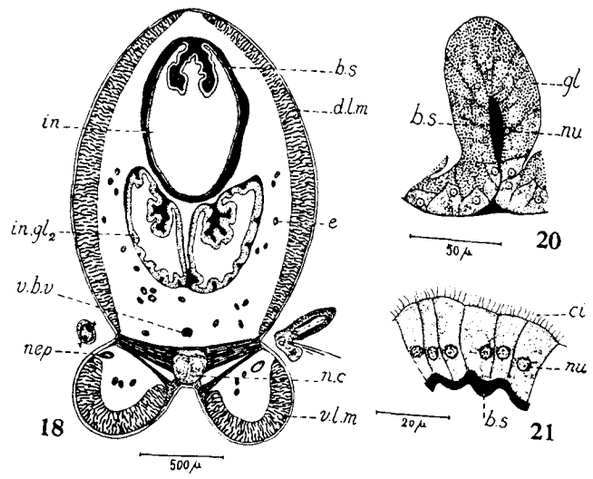
The anterior end of the stomach following the oesophagus shows complicated folds in the stomachal wall and is comparatively narrow. Beyond this region the stomach enlarges and has a thick wall composed of two or three layers of large cells (Fig. 14, *st*). These cells contain some yellowish substance and seem to be comparable to the chloragogenous cells described in *Arenicola* by Ashworth (1904).

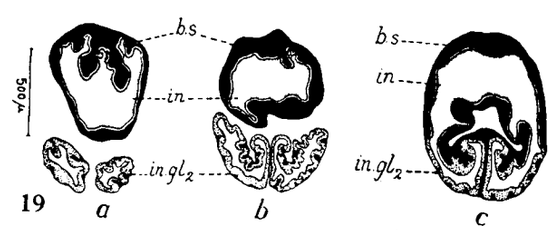
The stomach leads to the intenstine at about the 8th segment without any constriction at the transition. A pair of digestive glands open directly into the anterior region of the intestine. Each gland is a conspicuous tubular structure measuring 1.2 - 2.0 mm. placed on either side of the intestine (Fig. 15 *in* gl_1) and extending over two segments with their blind ends directed anteriorly. Transverse sections of the gland in relation to the alimentary canal at successive stages are shown in figure 16 *a*, *b* and *c*. where the opening of the glands on the ventral



side of the intestine may be seen. The gland cells contain large granules most of which stain deeply with iron haematoxylin or acid fuchsin and are acidophilic while the others stain with aniline blue (Fig. 17). Posterior to these glands is another more or less similar pair of glands opening into the intestine but these are disposed more ventrally. The two glands (Fig. 18, *in.* gl_2) are seen in sections to lie closely pressed against each other on the ventral side of the intestine. Each has a tubular structure, the blind end of which is also directed anteriorly, with a central lumen and a thick wall often in a series of parallel

folds. The lumen of each gland communicates with the intestine by means of a narrow opening on the ventral side (Fig. 19, *a*, *b* and *c*). The cells are large and contain a number of secretory granules as in the first pair of glands and these granules also do not show much differ-

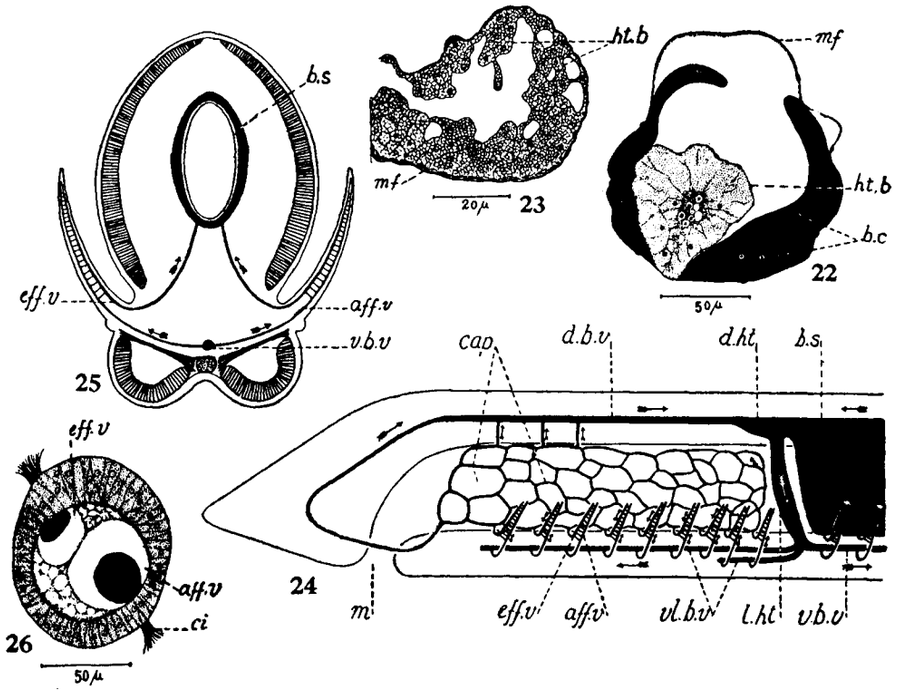




ence in their staining properties. These glands are probably comparable to those described in *Polyophthalmus pictus* as "Mittledarmdrüsen" (Meyer, 1882) on account of their close similarity in both position and structure. Brown (1938) does not describe the occurrence of any such intestinal glands in *Ophelia cluthensis*.

The wall of the intestine is composed of short ciliary cells (Fig. 21). In the initial region of the intestine there are usually one or two longitudinal folds, more or less like a typhlosole, either ventral or dorsal in position in the different specimens. The blood sinus surrounding the intestine also extends into these folds. The intestine is a straight tube and passes on to the anus without any structural change. Surrounding the anus is a long anal funnel which is a double-walled tube with a few transverse membraneous partitions between them. The posterior rim of the funnel is fringed with 10-11 anal papillae and a ventral median, long, anal cirrus.

Circulatory system: The heart is represented by a thin-walled expansion of the dorsal blood vessel at about the junction of the stomach and the intestine. In the living animal the heart is in a regular state of contraction and expansion and during systole it can hardly be distinguished from the dorsal vessel. The cardiac wall is supplied by a number of slender muscle fibres. Inside the heart and attached to its ventral wall is a core of tissue composed of large cells, some of which show small vacuoles in them. The cell walls are not very distinct whereas the nuclei stain well (Fig. 22, *ht.b*). Similarly, the heart gives off



two large lateral contractile vessels from its anterior end, often regarded as paired lateral hearts or lateral chambers of the heart, which also contain a loose spongy mass of cells extending into their cavity (Fig. 23). These structures found within the heart might correspond to the heart-body described in certain Opheliids and other families of polychaetes. The recent discussion by Kennedy and Dales (1958) on the function of heart-body in polychaetes reveals that it has a "haematopoieic" function.

The two lateral contractile vessels curve round the alimentary canal on either side and meet ventrally from where arise two pairs of anterior ventro-lateral vessels and a single, unpaired median vessel posteriorly. One pair of these anterior ventro-lateral vessels gives off branches to

the gills of the 10th and 9th segments while the other pair is situated just above the oblique muscles and sends afferent branches to the branchiae of the rest of anterior segments. The efferent vessels from all these ten anterior gills break up into capillaries around the proboscis, pharynx and oesophagus. The blood is collected by three pairs of vessels closely adhering to the septa and opening into the dorsal blood vessel. In addition to these, there is a pair of vessels collecting blood from the region of the snout which also joins the dorsal blood vessel at its anterior end. Besides, the dorsal blood vessel also receives smaller paired vessels from the pharyngeal region and the body wall before it enters the heart.

The posterior unpaired median ventral vessel gives off afferent vessels to the branchiae on either side from the 12th segment onwards. Each afferent branchial vessel starts from the main ventral blood vessel and curves round either side of the nerve cord and bends upwards to enter the gill. But before passing into the gill a branch is given off to the nephridium of that segment. Along the length of the branchia the efferent vessel gives off fine transverse vessels to the efferent branchial vessel which leaves the gill and enters the perivisceral blood sinus. In the living animal the gills appear red in colour owing to the blood filling the vessels. Figure 26 shows a transverse section of a gill with a thin layer of muscle fibres just beneath the epidermis and two rows of long cilia along its length to help in maintaining a constant current of water around it.

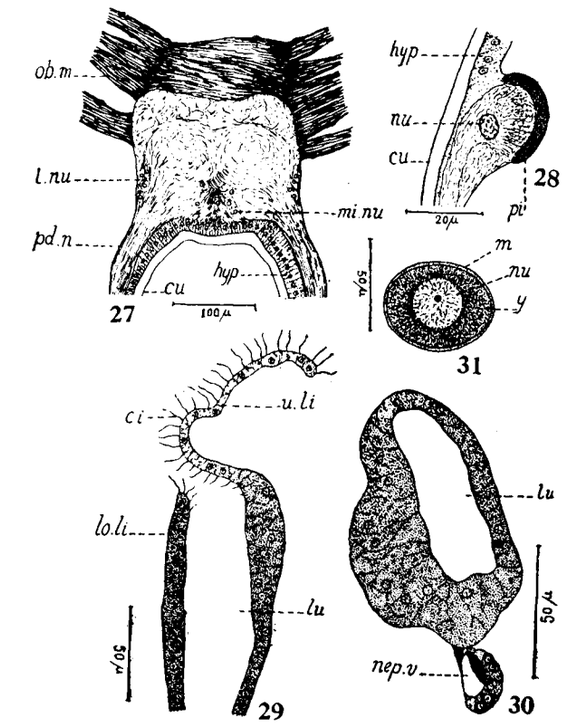
The blood sinus surrounding the intestine is spacious and shows a forward peristaltic contraction which in the living animal can be seen through the body wall. The blood has a red colour when fresh, due to haemoglobin dissolved in the plasma as in other Opheliids, and also contains a small number of round or slightly ovoid corpuscles.

The general course of circulation through the principal vessels is indicated diagrammatically in figures 24 and 25. The dorsal and lateral chambers of the heart by their contraction force blood into the posterior ventral vessels. Afferent branchial vessels given off from these ventral blood vessels carry blood into the gills. The efferent branchial vessels from the gills of the region in front of the heart break up into capillaries around the pharynx and the oesophagus and those of the posterior region enter the intestinal blood sinus. Small vessels from the prostomium and three principal vessels from around the pharynx collect blood and return it to the dorsal chamber of the heart by means of the dorsal blood vessel. On its way the dorsal blood vessel receives smaller vessels from the body wall and the alimentary canal. The blood from the posterior region is pumped back into the heart by the forward contraction of the perivisceral blood sinus.

Nervous system: The brain is situated in the prostomium and is composed of two cerebral ganglia fused to form the brain mass placed

a little in front of the nuchal organs. It gives off anteriorly a pair of nerves to the tip of the snout. From either side of the brain arises a stout nerve entering the body wall just anterior to the nuchal organs. Pruvot (1885) and Brown (1938) consider these nerves as actual prolongations of the brain itself. A transverse section of the brain shows roughly a trapezoid shape (Fig. 8). The histology of the brain and the nervous system in Opheliids has been described earlier by Kukenthal (1887). In the brain mass two groups of ganglionic cells are seen, each in the dorso-lateral corner. Eyes occur as small pigment cups sunk in the tissue of the brain. Proceeding from the posterior end of the brain are a pair of nerves supplying the nuchal organs.

The circumpharyngeal connectives start from the ventral side of the brain, curve round the pharynx in a postero-ventral direction and meet ventrally at about the level of the second segment. At the point of fusion of the connectives is a slight enlargement representing a small sub-pharyngeal ganglion. The ventral nerve cord begins from the 2nd



segment and shows two main longitudinal nerve bundles with intermittent groups of ganglionic cells along its length. There is usually a central group and two lateral groups of nuclei (Fig. 27, *l. nu; mi. nu*).

Podial nerves (*pd. n*) and also slender branches to the body wall are given off in each segment.

Sense organs: The principal sense organs are the prostomium, the nuchal organs and the eyes. The hypodermis of the prostomium is highly sensitive and is supplied with a pair of nerves from the anterior region of the brain. The prostomium thus serves also as a tactile organ in addition to its burrowing function. At the place where the nerves enter the body wall the hypodermal cells are tall and columnar but do not show any definite modification into what may be called a sense organ. However, the nerve supply might indicate a kind of sensory function for these cells. The paired ciliated nuchal organs are situated on the dorso-lateral region of the head and are eversible in the living animal. These organs are innervated directly by a pair of nerves from the posterior part of the brain. Each is a cup-like structure lined by columnar cells having cilia (Fig. 9) which work vigorously when the nuchal organ is everted. In *Polyophthalmus pictus* Meyer (1882) has described a "Becherformiges organ" or the cupiliferous organ in a coresponding position on the prostomium. The function of the nuchal organ has not so far been properly established. These were considered by some early workers as organs for producing a current of water to help the animal in feeding. While their position and nerve supply strongly suggest either on olfactory or chemoreceptor function, their eversible nature may be explained as a device for getting rid of any particle that might get into them during burrowing into the sand.

Cephalic eyes, two or sometimes three in number, are submerged in the tissue of the brain as in other members of the family and in section each appears as a simple pigment cup with no differentiation into retinal cells. With their small size and simple organisation they are in no way comparable to the more well developed eyes of other errant forms (Tampi, 1947), but are more like those seen in some of the larval forms. The burrowing mode of life of these polychaetes may be largely responsible for such poorly developed eyes. In addition to these cephalic eyes there are a few paired lateral eye spots occurring on either side of the body from the 7th segment which appear as small dark brown pigment spots of about 36 micra in diameter. Each eye spot in section (Fig. 28) shows a structure almost similar to that of the cephalic eyes composed of a pigment cup enclosing a large central nucleus and innervated by a branch from the ventral nerve cord.

Nephridia: Nephridia occur from the 12th segment and are present in all except the last 4 or 5 segments. Each nephridium is divisible into three regions, an inner funnel, a short excretory zone and a slightly looped conducting tube opening to the outside by means of a nephridiopore. The funnel is provided with a hood-like lip and is composed of ciliated cells. The excretory part of the nephridium is usually greenish brown in colour owing to the presence of green and yellowish brown excretory granules in the cells (Fig. 30). Cilia are absent in this region.

The terminal conducting portion has relatively clear cells with cilia which work actively in a direction away from the nephrostome and towards the nephridiopore. There is no external prominence of the nephridial opening unlike in *Ophelia cluthensis* where the nephridiopore is situated on papillae. The lumen of the nephridia is so narrow especially in the terminal part that it is difficult to consider these functioning as ducts for conveying the genital products, particularly the comparatively large ova, to the outside. Blood supply to the segmental organs is by means of branches from the afferent branchial vessels. This small nephridial vessel lies along the length of the nephridium up to about its middle and ends blindly. The presence of such blindly ending vessels round the segmental organs in Opheliids and other polychaetes has been noticed by Schaeppi (1894) and Ewer (1941). Surrounding the nephridial vessels are a group of cells whose function is not known except in certain similar instances where they are believed to be excretory in function.

It may be seen from the above description that the segmental organs in *Armandia* conform to the metanephridial type. The nephridial funnel is narrow and is only the enlarged inner end of the nephridial tube. The cells of the funnel also have more or less the same structure as that of the rest of the nephridium forming a nephrostome with no indication of a true coelomostome. Although Brown (1938) does not mention the exact nature of the nephridia in *Ophelia cluthensis* his description seems to indicate that it is also of the metanephridial type. However, Goodrich (1900 and 1945) has mentioned Opheliids as possessing a nephromyxia and a more critical study of the development of the nephridia in *Armandia* and other Opheliids seem to be necessary to ascertain their true nature.

Reproductive elements: The coelomic oocytes are pale green, discoid, oval bodies with an average size of 65 × 35 micra. Each oocyte is surrounded by a membrane and has a large centrally placed nucleus (Fig. 31) with a darkly staining nucleolus. Small yolk granules are densely aggregated around the nucleus. The size of these oocytes compare with those in *Thoracophelia* (Dales, 1952) but are much smaller than in *Ophelia* described by Brown (1938).

Spermatozoa arise inside the body cavity of the males from "sperm plates" as in other polychaetes and until they are mature float in the coelomic fluid in small masses each consisting of a large number of spermatozoa attached by their heads to a hollow sphere of protoplasm. The ripe spermatozoon contains a large nucleus and a long vibratile tail.

Sexes are separate in the species as in other Opheliids. It seems probable that the reproductive elements escape by the rupture of the body wall and not by way of the nephridia for reasons already explained although no actual observation has been made. Beniham (1901)

believes that the eggs in Opheliids are laid in a jelly. There are very few records of observations on the actual spawning in these worms. Fauvel (1927) and Wilson (1948) *a*) have pointed out that *Polyophthalmus pictus* becomes pelagic at night during its sexual phase although recently Tampi (1958) has observed that even juveniles of this species sometimes exhibit this swarming tendency. McGuire (1935) in his original notes on *Ophelia cluthensis* from the Millport area mentions the species as having two broods in the year—in April and in September, while in *Thoracophelia mucronata* along the California coast Dales (1952) mentions a prolonged breeding period for the species throughout the summer. The only observation on *Armandia* is that most of the worms collected in February-March were sexually mature or nearly so indicating their maturity during this period of the year.

Summary

The anatomy of the common Opheliid polychaete *Armandia leptocirris* occuring in the intertidal areas in Krusadai Island in the Gulf of Mannar is described pointing out the salient comparative anatomical features with those of other known Opheliids.

The coelomic cavity is a continuous space excepting for three septa in the anterior region. The oblique muscles have attained remarkable development in the species and these together with the four longitudinal muscle bands help the animal in its swift movements in the sandy habitat. Two pairs of conspicuous digestive glands open into the intestine. Both the vascular system and the nervous system are of the true anneliden type. A heart-body has been observed in the species. Excretory organs of the metanephridial type occur from the 12th segment. The species is dioecious.

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Key to Lettering

a. c.	anal cirrus	*mr. gr.*	midventral groove
a. f.	anal funnel	*n. c.*	nerve cord
a. p.	anal papilla	*nep.*	nephridium
aff. v.	afferent branchial vessel	*nep. v.*	nephridial blood vessel
b. c.	blood corpuscle	*nu.*	nucleus
b. s.	blood sinus	*nuc.*	nuchal organ
br.	brain	*ob. m.*	oblique muscle
cap.	capillaries	*oe.*	oesophagus
ci.	cilia	*oe. po.*	oesophageal pouch
coe.	coelome	*or. m.*	oral muscle
cu.	cuticle	*or. t.*	oral tentacle
d. b. v.	dorsal blood vessel	*p.*	prostomium
d. l. m.	dorsal longitudinal muscle	*parl.*	first parapodium

d. h. t.	dorsal chamber of the heart	*pd. n.*	podial nerve
e.	eye	*ph.*	pharynx
eff. v.	efferent branchial vessel	*ph. gl.*	pharyngeal glands
eg.	oocyte	*pi.*	pigment
g.	gill	*pr.*	proboscis
gl.	gland cell	*r. nuc.*	retractor muscle of the nuchal organ
ht. b.	heart-body		
hyp.	hypodermis	*r. ph.*	retractor of the pharynx
in.	intestine	*r. pr.*	retractor of the proboscis
in. gl$_1$ & *in. gl*$_2$	first and second pair of intestinal glands	*se*1, *se*2 & *se*3	septa
incl.	inclusions	*sp.*	spermatogonium
l. ht.	lateral heart	*st.*	stomach
l. nu.	lateral nuclear group	*u. li.*	upper lip of nephridium
lo. li.	lower lip of the nephridium	*v. b. v.*	ventral blood vessel
lu.	lumen of the nephridium	*v. l. m.*	ventral longtitudinal muscles
m.	mouth	*vl. gr.*	ventro-lateral groove
me.	membrane	*vl. b. v.*	ventro-lateral blood vessel
mf.	muscle fibres	*y.*	yolk
mi. nu.	middle nuclear group		

Chromosomes of *Viviparus dissimilis* (Muller) and *Viviparus bengalensis* (Lamarck) (Prosobranchia - Gastropoda)

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(Communicated by Prof. R. V. SESHAIYA, F.Z.S.I.,)

CONTENTS

Introduction

From the standpoint of chromosome cytology the Mollusca are one of the least known groups. Of the very large numbers of species constituting the phylum, the chromosomes of only 3 species of Lamellibranchs, about 131 species of Gastropoda and one species of Cephalopoda are known. Even among these, the account in many cases is limited to the mere enumeration of chromosomes. Among the Gastropoda, the largest of the molluscan classes, the Prosobranchs have received little attention compared with Opisthobranchs and Pulmonates. The paucity of our knowledge of molluscan chromosomes is mainly due to the small size of the chromosomes and technical difficulties. All the Prosobranchs studied so far have been mostly from Europe, America and Japan. The only Indian species studied so far are the Melaniid species investigated recently by Jacob (1957, '58).

The present account deals with the chromosomes of two Indian species of *Viviparus*, *Viviparus dissimilis*. (Muller) and *Viviparus bengalensis* (Lamarck). The European species of *Viviparus* have been particularly well studied. Special mention may be made of the investigations of Meves (1902) and of Pollister and Pollister (1943).

Material and Methods

Specimens of *Viviparus dissimilis* were collected from freshwater ponds in the University campus. Specimens of *Viviparus bengalensis*

were obtained from Nellore (Andhra Pradesh). The testes were dissected from the animals and fixed immediately in Carnoy, San felice and Bouin's fluids. Iron alum haematoxylin, crystal violet and Feulgen were used for staining the sections. The study of sections was supplemented by acetocarmine and Feulgen squashes of the different stages.

Observations

Viviparus dissimilis:

The number of chromosomes as determined from a study of a number of spermatogonial plates is 2n=22. A polar view of one such plate is shown in Fig. 1. A careful examination of the plate shows that the chromosomes lying close together are very similar in size and shape. All the chromosomes are metacentrics. The chromosome complex consists of eleven homologous pairs of which six pairs are large while the rest are small (Table 2). Of the former, four pairs are 'V'--shaped and have median centromeres, while the other two pairs appear 'J'-shaped and have submedian centromeres. Of the small chromosomes, two pairs of chromosomes are 'V'-shaped and have median spindle attachments, and three pairs have subterminal centromeres.

Meiosis:

During the resting stage one, or sometimes two large nucleoli can be seen. Chromatin blocks of irregular shape can be seen in the nucleus following the resting stage. At the approach of division, the blocks are resolved into fine granules of uniform size from which the leptotene threads are formed. During the zygotene stage the threads show a tendency to polarisation which increases in the pachytene. The analysis of the diplotene shows clearly eleven separate bivalents with the chiasmata formed. The distribution of chiasmata is not uniform. The number varies from one to three. Two or three cross-shaped configurations are commonly met with indicating the occurrence of single cross-over points (chiasma) between the chromosomes. Fig. 3. shows the diplotene group from a single nucleus. As seen from Table 1. the chiasma frequency at this stage is 1.36. At diakinesis stage the frequency is 1.36. In this stage the chromosomes are condensed and appear with smooth outlines. At metaphase the bivalents are so much condensed that all the bivalents appear as smooth round dots in the polar view, and more or less dumb-bell shaped in the side view. The chiasma frequency at this stage is 1.27.

It will be seen from Table 1. that the degree of terminalisation is greater between diakinesis and metaphase and is very slight between diakinesis and diplotene stage.

During the second division of the metaphase the chromosomes are 'V'-shaped with equal and unequal arms and lie distributed in the

Ramamoorthy *Plate 2*

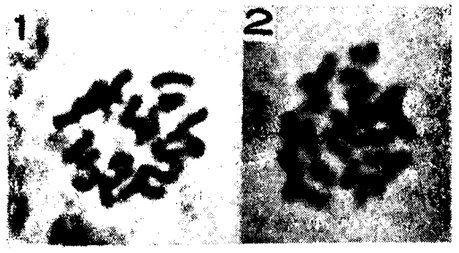

Fig. 1. Polar view of spermatogonial metaphase of *Viviparus dissimilis*. Photomicrograph acetocarmine squash. X ca. 4500.

Fig. 2. Polar view of spermatogonial metaphase of *Viviparus bengalensis*. Photomicrograph acetocarmine squash. X ca 4500.

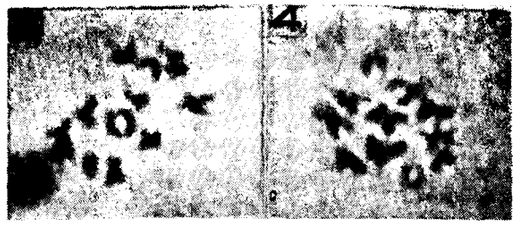

Fig. 3. Photomicrograph of nucleus during diplotene stage in *Viviparus dissimilis*-acetocarmine squash. X ca. 4500.

Fig. 4. Photomicrograph of nucleus during diplotene stage *Viviparus bengalensis*-acetocarmine squash. X ca. 4500.

equatorial region, radially round the spindle axis with their centromere regions pointing towards the division centre.

Viviparus bengalensis:

The polar view of the spermatogonial metaphase plate (Fig. 2) shows that the diploid number is 22. Of the eleven pairs of chromosomes, two chromosomes appear large, three pairs are small, while the rest seven pairs are median in size (Table. 2). One pair of large chromosomes appear as 'J'-shaped and have subterminal centromeres. All the rest appear as 'V'-shaped and have median centromeres.

The diplotene analysis shows clearly eleven separate bivalents and one such group is shown in Fig. 4. The chiasma frequency at diplotene stage is 1.63 and at diakinesis 1.36 and at metaphase 1.27. The degree of terminalisation as seen from Table 1. is slight between diplotene and diakinesis and slightly higher between diakinesis and metaphase.

In both the species, as stated already, the diploid number is 22. But in *Viviparus dissimilis* there are 5 pairs of chromosomes with unequal arms whereas in *Viviparus bengalensis* only one pair of chromosomes have unequal arms. All the chromosomes are metacentrics in both the species.

The bivalents are simple in form, much condensed and very short. No differential behaviour of any of the bivalent is seen.

The chiasma frequency shows a higher value in *V. bengalensis* than in V. *dissimilis* and the degree of terminalsation is great between diakinesis and metaphase in *V. dissimilis* and slight in *V. bengalensis.*

Discussion

Makino (1951) has listed the chromosome numbers of five species of Viviparidae. Among the American species described by Pollister (1939), Pollister and Pollister (1940) *Vivipara malleatus* has 2n = 18, *V. contectoides* and *V. intertestus* 2n = 26, *V. georgianus* 2n = 24. Recently Inaba and Tanaka (1953) have examined the chromosome number of *Viviparus* (*Cibangopaludina*) *malleatus* (2n = 18). The chromosome number of *Paludina vivipara* (*Vivipara viviparus*) has been variously given by different authors. Meves has mentioned 2n = 14, but Ankel has given 2n = 34.

In the Indian forms in both the species the diploid number is 22. Though the number is the same, the morphology of the chromosomes is quite distinct in the two species, with six pairs of large chromosomes in *Viviparus dissimilis* and one pair in *Viviparus bengalensis* and six pairs of chromosomes with median and five pairs with subterminal centromeres in *Viviparus dissimilis*, and one pair of chromosomes with

subterminal and ten pairs with median centromeres in *Viviparus bengalensis*.

Summary

1. The chromosomes of *Viviparus dissimilis* (Muller) and *Viviparus bengalensis* (Lamarck) have been studied. The diploid number is 22, and all the chromosomes are metacentrics.

2. The chiasma frequency is slightly higher in *Viviparus bengalensis* than in *Viviparus dissimilis*, and the terminalisation coefficient is greater between diakinesis and metaphase in *Viviparus dissimilis* and very slight between diakinesis and metaphase in *Viviparus bengalensis* as found from the counts at different stages.

Acknowledgment

My thanks are due to Prof. R. V. Seshaiya, Director and Professor, Marine Biological Station, Portonovo for suggesting the problem and for guidance, and to the Government of India, for the award of a senior research scholarship.

TABLE 1—*Chiasma frequencies and terminalisation coefficient at different stages*

Stage		*Viviparus dissimilis*	*Viviparus bengalensis*
Diplotene	Chiasma frequency per bivalent	1.36	1.63
	Terminalisation coefficient	0.13	0.11
Diakinesis	Chiasma frequency per bivalent	1.36	1.36
	Terminalisation coefficient	0.26	0.26
Metaphase	Chiasma frequency per bivalent	1.27	1.27
	Terminalisation coefficient	0.85	0.35

TABLE 2—*Differences between the chromosomes of Viviparus species*

No.	Names of the species	Diploid chromosome number	Big chromosomes			Median chromosomes	Small chromosomes	
			Median centromeres	Sub-median centromeres		Median centromeres	Sub-median centromeres	
1.	*Viviparus dissimilis*	22	8	4		—	4	6
2.	*Viviparus bengalensis*	22	—	2		14	6	—

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Observations on The Pink Mite, *Acaphylla theae* (Watt) Keifer, of Tea in North-East India

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CONTENTS

Introduction

The Eriophyid mite which is popularly known as the pink mite in North-East India was discovered on tea, *Camellia sinensis* (L.) O. Kuntze in Assam in 1895 by Sir George Watt who subsequently described it as a new species, *Phytoptus theae* (Watt, 1898). He also recorded the presence of the purple mite, *Calacarus carinatus* Green, found along with the pink mite in a number of cases. Subsequently, it was recorded as a serious pest of tea in Cachar and the Dooars and to a certain extent in Darjeeling (Watt and Mann, 1903). For some time, it was little heard of until it occurred in Cachar and the Dooars in 1917 (Andrews, 1918). It attained serious proportions in Cachar in 1919 (Andrews, 1920) but in the following year the attack partially subsided (Andrews, 1921). Since then, there was no published record of its occurrence, until another serious outbreak occurred in a tea estate in Jorhat, Assam, in 1951 (Das, 1951). During the last five or six years it has been reported from several tea estates, particularly from Upper Assam, and in some cases it appeared in damaging numbers.

Synonymy

Phytoptus theae Watt.—The Pests and Blights of the Tea Plant, pp. 400-408, fig. 11, 1898.

Phytoptus theae Watt.—Bernard, Meded. Proefst. Thee, 3: pp. 52-60, pl. 4, figs. 33-36, 1909.

Eriophyes theae (Watt).—Menzel, Arch. Theecult. (Indon.), 1: pp. 44-45, fig. 5 (4), 1929.

Eriophyes theae (Watt).—Pasquier, Principales maladies parasitaires du Theier et du Cafeier en Extreme-Orient, pp. 127-131, fig. 45, 1933.

Acaphylla steinwedeni Keifer.—Bull. Dep. Agri. Calif., 32 (3): pp. 212-222, pl. 176, 1943.

As stated, this mite was first described by Watt in 1895 as *Phytoptus theae*. Keifer (1943) described it as a new species *Acaphylla steinwedeni* from the specimens collected by him and Mr. Steinweden on *Camellia japonica* L. in California. He was not, however, aware that the pink mite was different from the purple mite, *Calacarus carinatus* (Green). Keifer (1954) mentioned that the name *theae* Watt was listed by Nalepa in 1929, along with *carinatus* Green as a 'nude name' and in a personal communication with the senior author, he stated that he had the idea that '*theae*' was another name for '*carinatus*'.

Though Watt's description of the mite is brief, it is accompanied by the illustrations of the adult and the young mite. Moreover, this mite is so well-known in tea and has always been referred to as *theae* that the change in the trivial name '*theae*' would only add confusion. The trivial name '*steinwedeni*' should, therefore, sink as a synonym of the earlier '*theae*'. But, since Keifer (1943) has given full description of the species and corrected the generic placement, the pink mite should henceforth be known as *Acaphylla theae* (Watt) Keifer.

Distribution

The pink mite is widely distributed in all tea districts of Assam and in the Dooars but it is less prevalent in Darjeeling. In South India it was reported to cause damage to tea (Anstead, 1909), but is hardly considered to be a pest nowadays. On tea, it also occurs in Indonesia (Bernard, 1909; Van Hall, 1926; Menzel, 1929), in Indo-China (Pasquier, 1933) and in Batum, U.S.S.R. (Demokidov, 1916), but has not been reported from Ceylon (Stuart-Light, 1927). In 1943, this mite was collected from *Camellia japonica* L. in Sacramento, California (Keifer, 1943). Keifer also mentioned that "specimens of this mite have also been seen from Southern California in 1942 and from Alabama camellia in 1941". Hall (1954) reported that this Eriophyid mite (*A. steinwedeni* Keifer) was collected on tea in Malaya for the first time in

1954, stating that Keifer had received specimens from tea elsewhere in Asia.

Habits and Injury

The pink mite attacks the leaves at the upper part of the bush but the young leaves are preferred. It occurs on both the surfaces but is more prevalent on the undersurface, particularly along the mid rib. Petioles and stems of young shoots are also attacked. The affected leaves become pale coloured, often leathery, the veins and the margins particularly on the undersurface showing pinkish discolouration. In severe damage, the whole of the undersurface may show a brownish discolouration. The affected leaves may also present a crinkled appearance.

The relative populations of this mite on upper and undersurfaces of young and mature leaves were assessed on a heavily attacked unpruned tea during the early part of the season for which 50 young leaves 1st—4th) and 50 mature leaves (from 5th down) were collected at random with the following results (Table I).

TABLE 1—*Populations of pink mite on the upper and under surfaces of leaves*

	Young leaves		Mature leaves	
	Upper surface	Under surface	Upper surface	Under surface
Average No. of mite per leaf.	85.3	1003.9	18.6	61.5
Percent occurring on	7.8	92.2	23.2	76.8

It will be evident from the above table that damage is mainly caused to the undersurface, particularly of the young leaves.

The pink mite attack cannot, however, be easily detected unless the leaves are carefully examined. The affected bushes have a pale and sickly appearance, and in a severe attack the growth of the shoots is very much retarded. There are instances where heavy loss of crop occurring without any perceptible cause, was later detected to be mainly due to the pink mite attack, and in certain cases areas reported to have

been suffering from the effect of drought were found to be damaged by the pink mite (Das, 1954). One tea estate in the Sibsagar district which had a severe outbreak of this mite in 1950-51 was reported to have lost 500 mds. of tea (Das, 1954) and another in Moran also suffered considerably in 1957. Watt and Mann (1903) recorded that a garden in Cachar had a loss of 21,500 lbs. of tea from an area of 75 acres, which they attributed principally, if not entirely to this pest.

It is a well known fact that pink mite prefers Assam kinds of tea to China. Hybrids closer to the Assam variety are more attacked than those nearer to China.

Relative populations of pink mite on two adjacent plots—one with an Assam kind of plants and the other with plants known as China hybrids—were estimated during the month of September. Assessment was made on 50 young leaves (1st—4th) collected at random from each plot and the results show that the pink mite population on the Assam kind is six times that on the China hybrid (*vide* table II).

TABLE 2—*Populations of pink mite on Assam and China kinds of tea*

	Total No. of adults and young mites	
	on 50 leaves	Average per leaf
Assam kind ...	3994	79.9
China hybrid ...	654	13.1

Life - History

Very little information is available on the life-history of the pink mite though it has been known as a pest of tea for more than half a century. The nymph and the adult were briefly described by Watt and Mann (1903) but no egg had been found by them.

Studies on the life-history of this mite were, therefore, made in the laboratory at different times of the year viz., in March, July-August, and December-January. The data are summarised in the table III.

TABLE 3—*Life-history data of pink mite*

Experiment No.	Date of ovi-position	Mean temperature (oC)	Mean humidity (percent)	Number of mites	Average duration (days)		
					Egg stage	Nymyhal stage	Life-cycle (egg to adult
1	27— 3—57	24.2	83.8	2	3.8	4.8	8.6
2	28— 3—57	24.3	83.8	7	3.6	5.1	8.7
3	29— 3—57	24.4	84.1	2	3.0	5.0	8.0
4	16— 7—54	29.3	86.0	3	2.3	3.5	5.8
5	27— 7—54	28.7	88.9	2	2.5	4.0	6.5
6	28— 7—54	28.9	88.5	1	3.0	4.0	7.0
7	16— 8—54	29.7	85.8	10	2.6	3.7	6.3
8	17— 8—54	29.7	85.4	9	2.7	3.3	6.0
9	19— 8—54	29.1	86.4	11	2.5	3.1	5.6
10	20— 8—54	29 0	85.5	14	2.6	3.3	5.9
11	11— 1—55	19.3	82.0	1	6.5	7.0	13.5
12	12— 1—55	19.2	82.1	4	6.3	6.8	13.1
13	6—12—57	20.0	82.3	6	5.7	6.3	12.0
14	7—12—57	20.0	82.7	6	6.0	6.5	12.5

The time taken from egg to adult averaged 8.4 days, ranging from 8.0 to 8.7 days during March when the average mean temperature and humidity were 24.3°C and 83.9 percent respectively. In July and August when the average mean temperature and humidity were 29.2°C and 86.6 percent respectively, the life-cycle was completed in 5.6 to 7.0 days, with an average of 6.2 days, but in the cold weather (December and January) when the average mean temperature and humidity were 19.6°C and 82.3 percent respectively, it took 12.0 to 13.5 days, the average being 12.8 days.

The maximum life of an adult was found to be 16 days with an average of 12 days under the laboratory conditions, but it may be a little longer in the field. The total number of eggs laid by a female could not be ascertained as frequent transfer of the females from one leaf to another resulted in their early death. It, however, lays 2-4 eggs per day and it is assumed that a female may lay 30-40 eggs during its life time.

TABLE 4—*Effect of treatments on the population of pink mite*

Treatments	Average population per leaf after—		Percent reduction per check after—	
	One week	Two weeks	One week	Two weeks
Lime-sulphur containing 22–26% polysulphide at 1 in 40 parts water ...	3.8	2.1	99.1	98.4
'Thiovit' (a wettable sulphur) at 1 lb. in 10 gals. water ...	1.4	4.1	99.7	96.8
'Akar 338' (chlorobenzilate 25% emulsifiable concentrate) at 1 pint in 62½ gals. water. ...	17.2	5.1	95.8	96.1
Malathion 50% Emulsifiable concentrate at 1 pint in 50 gals. water ...	44.1	26.0	89.2	79.9
'Aramite' 15% wettable powder at 1 lb. in 50 gals. water. ...	98.8	26.8	75.9	79.3
Check ...	409.0	129.4	—	—
Significant difference at 5% level ...	146.7	23.3		
Rainfall between treatment and obeervation ...	19.69 cm.	34.72 cm.		

From the results of observations made after a week, it is evident that all the acaricides proved to be highly effective in reducing the pink mite population, and there was no significant difference between the efficacy of the acaricides. There were, however, heavy rains starting on the 5th day of treatment which do not seem to have reduced the efficacy of the acaricides, since most of the stages were killed in the meantime either due to the contact action of the acaricides or their residues. Observations made after two weeks showed that the reduction in the pink mite population was significant in all treatments of acaricides. The performance of 'Akar 338' was similar to that of lime-sulphur and Thiovit, while Malthion and Aramite were slightly inferior to lime-sulphur. The reduction in the population of the pink mite in check as

observed after two weeks, appears to be due to heavy rains which washed off the mites.

Remarks on the use of Akar, Aramite and Malathion on tea

The residues of Akar and Aramite on made tea at the concentrations tried out, have been evaluated by the respective manufacturers of the chemicals from the samples supplied by the Tocklai Experimental Station and are found to be lower than the tolerance levels fixed by the Food and Drug Administration, U.S.A., for these chemicals on raw tion and are found to be lower than the tolerance levels fixed by agricultural commodities. Tea has not yet been scheduled for any Plant Protection chemicals, but in view of the success of Akar and Aramite in the above, and other experiments, the manufacturers are undertaking to have the tolerance levels for these chemicals on made tea declared in accordance with the act concerned.

Until the tolerance levels for Akar and Aramite on made tea are scheduled, it is in the interest of the Tea Industry of this country that their use should be confined to tea not in plucking. They can however be used on flushing tea during the early part of the season, at least two weeks before plucking commences. It may be mentioned that both Akar and Aramite have been found to produce no taint in made tea.

On the other hand, the use of organo-phosphorus compounds for the protection of tea and ancillary crops is not advocated since most of them are highly toxic to mammals and involve a great risk to the health of spraying operators. Malathion is, however, said to be of low mammalian toxicity and its residue tolerance on raw agricultural commodities is quite high. Even then, till it is definitely proved that it is not absorbed by the plant tissues and thus carried over to made tea, it is advisable that its use be confined to tea during the off season and to young tea not in bearing. Action is being taken to obtain a scheduled tolerance level for Malathion residues on tea.

Summary

The pink mite, *Acaphylla theae* (Watt) Keifer, has been known as a pest from the early days of tea plantation in North-East India, at times causing considerable damage to tea, but in recent years it has been recorded in consistently damaging proportions. It has been recorded on tea, *Camellia sinensis* (L.) O. Kuntze in South India, Indo-China, Malaya and Batum (U.S.S.R.) and on an allied species of Camellia in California and Alabama. It occurs on tea throughout the year, but a serious attack may develop between March and June, particularly when a prolonged dry period prevails. The affected leaves become pale, with the veins and margins showing pinkish discolouration. The Assam kinds of tea are much more attacked than the China hybrids.

The pest is a small Eriophyid mite, 0.142-0.189 mm. long. Its life-history is completed in 8.0-8.7 days in March, in 5.6-7.0 days in July-August and in 12.0-13.5 days in December-January. The length of life of the adult is 8-16 days under the laboratory conditions.

Sulphur, lime-sulphur and Akar are highly effective against this mite, while Malathion and Aramite also give effective control, but they are slightly inferior to lime-sulphur.

Acknowledgements

The authors are grateful to Mr. H. Ferguson, Director, Tocklai Experimental Station for his suggestions, particularly regarding the use of persistent insecticides on tea and for permitting to publish this paper, and to Mr. H. H. Keifer, Systematic Entomologist, California Department of Agriculture, Bureau of Entomology, for his views regarding the popular name of the mite.

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Changes in the Free Amino Acids in the Different Stages of Ovary of the Fish, *Labeo fimbriatus* (Bloch), *Mystus seenghala* (Sykes) and *Boleophthalmus boddaerti* (Day)

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(Communicated by Professor R. V. SESHAIYA, F.Z.S.I.)

CONTENTS

Introduction

The free amino acids in tissues constitute a sort of metabolic currency and their variations in the tissues reflect metabolic changes. The free amino acids of adult tissues of a number of animals have been described in recent years, but the variations in free amino acids during growth do not seem to have been investigated so far in any animal. However, the free amino acids during development have been investigated by Li and Roberts (1949) in amphibian development; and more recently by Deuchar (1955,58) in *Xenopus*, Chen (1956) in Urodele development, and Kavanau (1953,54) in sea-urchin embryo.

The present communication records the changes in the free amino acids in three different stages of the ovary in *Labeo fimbriatus* (Bloch) *Mystus seenghala* (Sykes) and *Boleophthalmus boddaerti* (Day).

Materials and Methods

Labeo fimbriatus and Mystus seenghala were collected from ponds in Annamalainagar during the different seasons of the year. Specimens of *Boleophthalmus boddaerti* were collected in the backwaters of the Vellar estuary at Portonovo during low tide.

The animals were dissected, and ovaries in three clearly marked stages-(i) immature (Stage I.), (ii) maturing (Stage II.) and mature

(Stage III.)-adopting Bower's classification (1951), were taken for study. The material was immediately put in 80% alcohol and well ground in a mortar with a little quartz sand. After centrifugation the supernatant liquid was treated with thrice the volume of chloroform, and after centrifugation again the upper layer alone was used for chromatographic analysis.

For the study of the free amino acids the circular filter-paper chromatographic procedure, as described by Giri (1952), with Whatman No. 1. filter paper of 13 cms. diameter was adopted. n-Butanol-acetic acid-water mixture (4:1:1) was used as the solvent and 0.1% ninhydrin in 95% acetone as the colour-developing reagent. For the identification of the different amino scids, mixed chromatograms as described by Giri and Rao (1952) were run by spotting both known and unknown samples in the same chromatogram. The technique of multiple development as described by these authors was also successfully adopted to identify amino acids which failed to separate as distinct bands.

Two-dimensional ascending chromatographic technique was also employed using a 25 × 25 cm. Whatman No. 1. filter paper. n-Butanol-acetic acid-water mixture and buffered phenol were used as solvents. 0.1% ninhydrin in 95% acetone was used as the colour-developing reagent. The amino acids were identified from the standard chromatogram and also from R_f values of the individual amino acids previously calculated.

Observations and Results

The qualitative distribution of free amino acids in three different stages of ovary of *Labeo fimbriatus*, *Mystus seenghala* and *Boleophthalmus boddaerti* is shown in the Table.

The more important findings are as follows:—

I. (a) Alanine, threonine, glutamic acid and aspartic acid, these four are the only amino acids present in common in all the fishes studied in all the three stages.

(b) Tryptophan and hydroxyproline are absent in all the stages in all the three fishes.

II. (a) There are nine free amino acids in the immature ovary of *Boleophthalmus* and *Labeo*, and eight in *Mystus seenghala*. But of these, only five are common to the three species in this stage, viz., valine, alanine, threonine, glutamic acid and aspartic acid (b) in *Boleophthalmus* methionine, arginine and lysine are present in addition to these five amino acids. (c) *Mystus* has in addition to the five common amino acids arginine and asparagine, and differs from *Boleophthalmus* in lacking methionine. (d) *Labeo* has besides the five common amino acids, tyrosine, histidine and glycine. It differs from *Mystus* in the absence of asparagine and arginine.

III. In the second or maturing stage, there are ten amino acids in *Mystus*, eleven in *Labeo* and ten in *Boleophthalmus*. Of these only four are common to the three fishes, viz., leucines, threonine, glutamic acid and aspartic acid.

IV. In the mature stage *Boleophthalmus* has seventeen, *Labeo* twelve and *Mystus* eleven amino acids. Of these, nine amino acids are common to all the three fish, viz., leucines, valine, methionine, alanine, threonine, glutamic acid, aspartic acid, histidine and arginine. The third stage of the ovary of *Boleophthalmus* differs from those of *Labeo* and *Mystus* in having lysine, ornithine and cystine. The presence of cystine in the third stage is very distinctive of *Boleophthalmus*, for this amino acid is not present in any of the other fishes examined in any stage. The third stage of the ovary in *Labeo* and *Mystus* can be distinguished by the presence of phenylalanine and asparagine in the former but not in the latter.

Summary

1. The free amino acids in three different stages of the growth of the ovary in *Labeo fimbriatus* (Bloch), *Mystus seenghala* (Sykes), and *Boleophthalmus boddaerti* (Day) have been investigated.

2. These three fishes have distinctive amino acid patterns characteristic for each of the three stages.

3. The free amino acids show a progressive increase in number during the development of the ovary. The mature ovary has nearly twice as many free amino acids as the immature ovary in *Boleophthalmus*.

4. The second stage shows the greatest variation in the three fishes, for there are only four amino acids common to them. The third stage has nine amino acids in common, and the first stage has five in common.

5. Evidently the second stage is a critical stage as it is most distinctive for each species. The increase in number of the free amino acids in the second and third stages probably indicates increased protein metabolism.

Acknowledgments

I am greatly indebted to Prof. R. V. Seshaiya, Professor and Director, Marine Biological Station, Portonovo (South India), Annamalai University for suggesting the problem, guidance and help. My thanks are also due to the Ministry of Education, Government of India for the award of a scholarship.

Table showing the Free Amino Acids of the Ovary of *Labeo fimbriatus*, *Mystus seenghala* and *Boleophthalmus boddaerti*

Free Amino Acids	*Labeo fimbriatus*			*Mystus seenghala*			*Boleophthalmus boddaerti*		
	Stages			Stages			Stages		
	I	II	III	I	II	III	I	II	III
A. Leucines	–	A	A	–	A	A	–	A	A
B. Phenylalanine	–	–	B	–	–	–	–	–	B
C. Valine	C	C	C	C	–	C	C	C	C
D. Methionine	–	D	D	–	–	D	D	D	D
E. Proline	–	–	–	–	–	–	–	–	E
F. Tyrosine	F	–	F	–	F	F	–	–	–
G. Alanine	G	G	G	G	G	G	G	G	G
H. Threonine	H	H	H	H	H	H	H	H	H
I. Glycine	I	I	–	–	I	–	I	I	I
J. Serine	J	J	–	J	J	J	–	–	J
K. Glutamic acid	K	K	K	K	K	K	K	K	K
L. Aspartic acid	L	L	L	L	L	L	L	L	L
M. Histidine	M	–	M	–	–	M	–	–	M
N. Arginine	–	N	N	N	–	N	N	N	N
O. Asparagine	–	O	O	O	–	–	–	O	O
P. Lysine	–	–	–	–	P	–	P	–	P
Q. Ornithine	–	–	–	–	Q	–	–	–	Q
R. Cystine	–	–	–	–	–	–	–	–	R

•Tryptophan and Hydroxyproline are not persent in the ovary of the three fishes in any stage and hence are not shown in the Table.

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Diurnal Tidal Cycle in Vellar Estuary

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CONTENTS

Introduction

An estuary is generally defined as that area in a river in which tidal effects are evident. The daily rhythm of the ebb and flow of the tides makes the physico-chemical environment in the estuary very complex and dynamic. Superimposed on the diurnal changes in the estuarine environment are the seasonal and annual changes. Estuarine biology can be properly understood only against the background of the ever-oscillating environment. Extensive observations on the seasonal changes in the hydrology and biology of estuaries have been made in U.K., U.S.A., South Africa and Australia. But detailed observations on the daily rhythm of changes in the hydrobiology of estuaries do not seem to have been made in any country so far.

The present communication is a preliminary glimpse into the kaleidoscopic changes in the hydrobiological pattern of the Vellar estuary.

The Vellar Estuary

The Vellar estuary is situated in Lat. 11° 29′ N and Long. 79° 49′ E at Porto Novo, S. India, where it flows into the Bay of Bengal. The bar of the estuary is always open, and as shown by Ramamoorthy (1954), the estuary is characterised by vertical salinity gradients. On the basis of these salinity gradients the estuary can be demarcated into (a) a

marine zone extending up the estuary for a distance of a mile from the mouth, with a mean salinity of 33.72 per 1,000 and having little or no difference in the salinity at the bottom and surface; (b) a tidal zone, exhibiting a maximum tidal rise and fall and also showing a progressive increase in the vertical haloclines towards the upper reaches of the estuary, the salinity being always higher at the bottom than at the surface; (c) a gradient zone with progressively decreasing haloclines and (d) the fresh-water zone at the head of the estuary with no haloclines.

It may be noted that in the Vellar estuary, as in the Tees investigated by Alexander, Southgate and Bassindale (1935), and the Tamar by Milne (1938), the incoming salt water from the sea does not mix completely with the river water.

Methods of Investigation

The observations relating to the tidal cycle recorded in this paper were made at a station in the tidal zone of the estuary, about two miles from the mouth and opposite the Porto Novo Marine Biological Station. The average depth at this place is 10 feet.

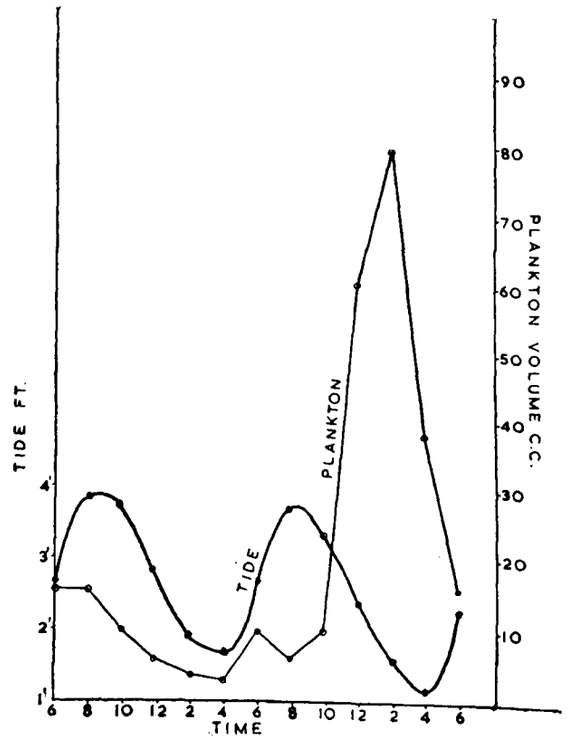
The observations which were commenced in 1956, have been made during spring tides on new moon or full moon days every month. Usually, the work was started at 6 a.m. and continued till 6 a.m. on the succeeding day, the observations being recorded every two hours. The present account relates to one such series of observations made on 11th-12th April, 1956, which is more or less typical for the summer months.

The temperatures of the bottom and surface were taken with a reversing thermometer. Water samples to within a foot of the bottom were taken with the 'horizontal water scoop'. The chemical analysis was carried out immediately, partly in the laboratory of the Biological Station and partly on its research vessel, the "*MEDUSA*". Observations on the velocity of water-currents both at the surface and bottom were made with the Watt's current meter and expressed in meters per second.

For the determination of salinity, Harvey's (1955) method was employed and frequently checked up with titrations against standard seawater. Carbonates and bicarbonates were estimated by the usual method of titrating 100 cc. of the sample against N/20 HCl using phenolphthalein and methyl-orange as indicators. For the determination of oxygen the Winkler's method was employed with the necessary precautions.

The plankton was collected with a net of bolting silk, which was towed for ten minutes on each occasion. The collections of plankton were fixed in 10% formalin and transferred to a graduated measuring cylinder. The organisms were allowed to settle for one or two days and

the volume of the plankton was noted. The concentrated plankton after the removal of macro-organisms, was numerically analysed by the method of Utermöhl (1931) using the plankton microscope. A tide staff was used for noting the rise and fall of the water. Turbidity was recorded only during daytime using a Secchi disc.



Graph 1. Graph showing two-hourly fluctuations in tide and plankton volume on 11th-12th April, 1956.

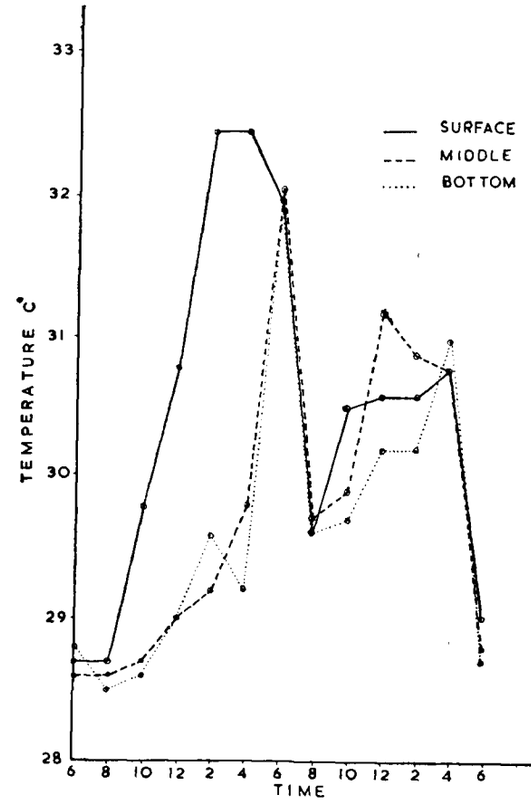
Tides and Tidal Range

There are two high and two low waters for every twenty-four hours, each with a duration of about six hours. When the moon is full or new, the morning high water occurs at 08 hrs. 41 mins. and the evening high water at 20 hrs. 40 mins. Graph 1 shows the tidal range during one complete tide cycle. The tide levels for the first high and low waters were 3′ 9″ and 1′ 7″ respectively (Table 1.) and for the second high and low waters 3′ 7″ and 1′ 2″ respectively.

The tidal range in the morning was 2′ 2″ and in the evening 2′ 5″ Generally, the tidal range in the evening is greater than in the morning.

Fluctuations in the Temperatures

In the surface-water the range of diurnal variation of temperature was 3.8° C, the lowest temperature which was recorded at 6 a.m. being 28.7° C, and the highest 32.5° at 2 p.m. The temperature remained



Graph 2. Graph showing two-hourly fluctuations in temperaturue of surface, middle and bottom waters on 11th-12th April 1956.
—— Surface; – – – – Middle; ..... Bottom.

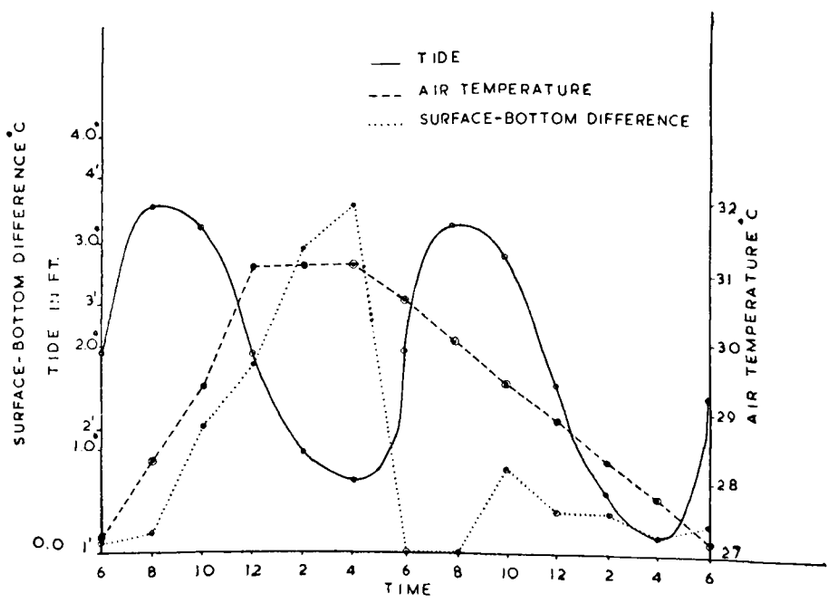
steady from 2 p.m. to 4 p.m. After 4 p.m. the temperature began to decline till 8 p.m. From 8 p.m. there was an increase till 4 a.m., after which there was again a fall. (Graph 2).

The atmosphere showed the lowest temperature of 27.2° C. at 6 a.m., and the maximum, which was 31.1° C., at 12 noon. From 12 noon to 4 p.m. the atmospheric temperature remained steady, and from 6 p.m. there was a steady fall till 6 a.m. Thus there was a fairly close correspondence during daytime between changes in the atmospheric temperature and the temperature of the surface waters. But during the

night, the atmospheric temperature decreased by 3.4 C., whereas the temperature of the surface-water showed an increase of 1.2 C. (from 29.6 C. to 30.8 C.) between 8 p.m. and 4 a.m. This is evidently due to the warm water masses of the upper shallow reaches of the estuary flowing down the estuary during second low water which occurs between 20 hrs. 41 mins. and 03 hrs. 02 mins. The range of variation in the surface temperature during the complete, diurnal tidal cycle was 3.8 C.

The temperature at the bottom shows a rather different type of fluctuation. From 6 a.m. till 4 p.m. the range of fluctuation was not more than 1.2 C., whereas in the surface the temperature fluctuated by 3.8 C. At 6 p.m. the temperature of the bottom reached the maximum and at this time the temperature was practically the same at the surface, in the middle and at the bottom. After 6 p.m. during the second high water the temperature of the bottom fell by 2.4 C and showed an increase from 10 p.m. till 4 a.m. when the temperature was 31.0 C. The range of variation of temperature at the bottom during the complete tidal cycle was 3.5 C.

Graph 3 shows the relationship between the air temperature, the tides and the difference in temperatures at the surface and bottom. At the time of first high water, a slight difference was noticed in the



Graph 3. Graph showing the relationship between atmospheric temperature, tide and the surface-bottom difference in temperature during one complete tidal cycle on 11th-12th April, 1956.

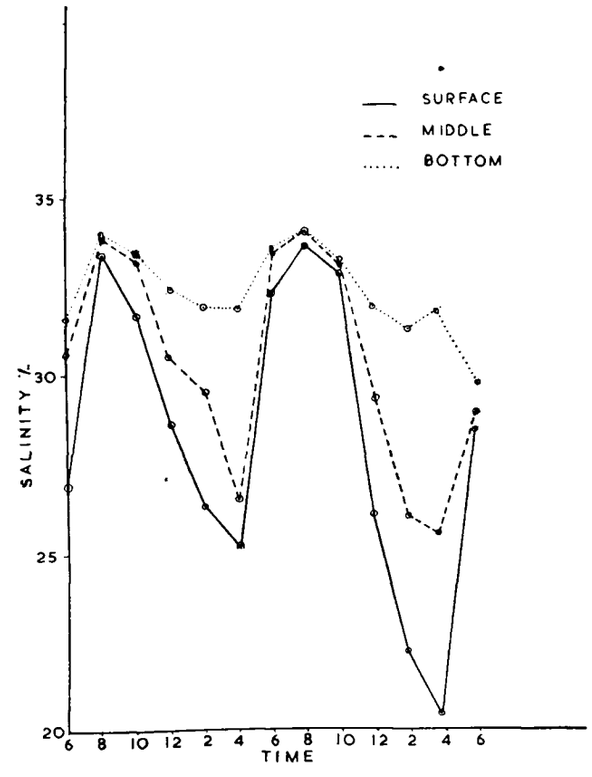
—— Tide — — — — Air temperature; ..... Difference in surface-bottom

temperature between surface and bottom. The maximum difference of 3.8 C. between the surface-bottom temperatures was noticed at the time of first low water.

It can be seen from the graph that the atmospheric temperature and the temperature difference between surface and bottom bear a close similarity. The maximum temperature of 31.1 C. in the air was recorded at 12 noon and the maximum difference of 3.3 C. between surface and bottom was recorded at 4 p.m. There is thus a time lag of 4 hours between the temperature peak of the atmosphere and the peak in the surface-bottom difference in temperature.

Salinity

The surface waters showed the maximum salinity at high tide in the morning and in the evening. At 8 a.m. the salinity was 33.63 per 1,000 and at 8 p.m. 33.83 per 1,000 At 4 p.m. and 4 a.m., when the tide was low, the surface salinity fell to 25.17 per 1,000 and 20.43 per



Graph 4. Graph showing two-hourly fluctuations in salinity of surface, middle and bottom waters on 11th-12th April 1956. —— Surface; — — — — Middle; ..... Bttoom.

1,000 respectively. The range of variation in salinity at the surface is 13.40 per 1,000 and the fluctuations correspond to the tidal variations.

At the bottom the range of variation in salinity during twenty four hours is only 4.32 per 1,000; the maximum recorded being 34.23 per 1,000 and the minimum of 29.91 per 1,000. The salinity at the bottom was throughout the day higher than at the surface and was also higher at high tide than at low tide. A reference to Table 1. will show that the bottom-surface difference in salinity is 0.60 per 1,000 at 8 a.m. and 0.40 per 1,000 at 8 p.m. when the tide is high. Further, at this time there is relatively little difference in the salinities between bottom, middle and surface, indicating that there is considerable mixing of neritic and estuarine waters, but not quite complete. At low tide, however, a well defined chlorinity conflict develops with clear differences in the salinities at the bottom, middle and surface.

It will be seen that the bottom waters are not greatly influenced by the tides. However some sea water evidently flows along the bottom at high tide, for the salinity of the bottom increases slightly at high tides.

Oxygen

The concentration of oxygen in the surface water varies from 4.8 p.p.m. to 7.4 p.p.m. during one complete diurnal tidal cycle (Tabel 1), the range of variation being 2.6 p.p.m. The lowest oxygen concentration was recorded at 4 a.m. in the surface water. The range of fluctuation in the concentration of oxygen at the bottom water during the tidal cycle was 2.2 p.p.m.

There is a general tendency for the oxygen concentration to increase in the surface water with the rise in temperature, the maximum of 7.4 p.p.m. being recorded at 4 p.m. From Table 1. it can be seen that the oxygen concentration in the surface water is always greater than that at the bottom.

The maximum difference in the oxygen concentration between surface and bottom waters during a tidal cycle was 2.0 p.p.m., and this was observed at 2 p.m. and also at 2 a.m.

Carbonates and Bicarbonates

The concentration of carbonates in the surface water varied from 0.0 p.p.m. to 10.0 p.p.m. and in the bottom water from 4.0 p.p.m, to 12.0 p.p.m. The concentration of bicarbonates in the surface layer showed wide fluctuations, from 8.0 p.p.m. to 44.0 p.p.m. and in the bottom water from 8.0 p.p.m. to 39.0 p.p.m. The maximum concentration of both carbonates and bicarbonates in surface and bottom waters occurred in the early hours of the day.

Currents and their Velocity

The maximum velocity of the 'flow' current on the surface that was observed during one tidal cycle is 0.227 meters per second, and that of the 'ebb' current is 0.455 meters per second. At the bottom the maximum velocity of the currents of the 'flow' and 'ebb' are 0.345 and 0.050 meters per second respectively. During ebb tide the velocity of current at the bottom is sometimes zero, indicating that there is no movement of water mass.

Analysis of the direction of current at the surface indicates some interesting features. The second high water sets in at the mouth of the river at 14 hrs. 55 mins. But at 16 hrs. the direction of flow in the river is still down the river with a velocity of 0.317 meters per second. The first high water on the succeeding day sets in at the mouth at 03 hours 02 mnutes but the direction of current in the river at 04 hrs. is down the river with a velocity of 0.300 meters per second. But at 06 hrs. the direction of the current has changed and it is up the river. This shows that it takes about 2 hours for the current to reverse its direction in the river after the onset of high waters at the mouth. Generally the 'ebb' current on the surface is faster than the 'flow' current (Table 1.)

Turbidity

During the first high water the estuarine water is less turbid due to the flow of sea water into the river. This is shown by the observation with the Secchi disc which disappears from view at a depth of 81.0 cms. at 10 a.m. After 10 a.m. the turbidity of the water increases, and at 6 p.m. the Secchi disc reading has the lowest value of 36.0 cms.

The high turbidity of the water at 4 p.m. and 6 p.m. is due to the large quantity of suspended matter carried by the river at the time of low water.

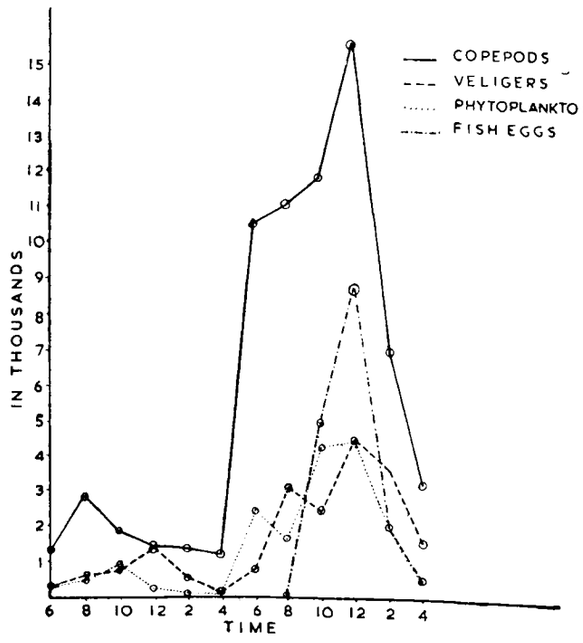
Plankton

The volume of plankton collected at the time of the first high water (8 a.m.) was only 16.0 cc. After 8 a.m. the volume of the plankton decreased and reached the low value of 3.0 cc. at 4 p.m. With the commencement of the second high water, the volume of the plankton collected increased and rose up to 10.0 cc. at 6 p.m., to 60.0 cc. at 12 midnight, and to 80.0 cc. at 2 a.m. But after 2 a.m. there is again a decline which reaches to 16.0 cc., and continued till 6 a.m. The changes in the volume of plankton in relation to the tide are shown in Graph 1. It will be seen that during daytime, from about 6 a.m. to 6 p.m., there is a general similarity in the trend of changes in the plankton-volume and tides. But after 6 p.m. there is an inverse relationship.

This means that during daytime the increase in the volume of plankton is due to flow of neritic waters, but at night the increase in plankton seems to be due to other causes like the migration of the endemic bottom organisms to the surface.

During high waters in daytime the neritic organisms like *Sagitta*, Ascidian tadpoles, *Pluteus* larvae, *Pteropods* and small *Medusae* occur in large numbers. *Copepods*, *Mysids*, fish eggs and larvae are few. But during the night Copepods, *Zoeae*, *Mysids*, *Veligers*, *Polychaete* larvae, fish eggs and larvae are quite common.

Graph 5 shows the diurnal fluctuations in some of the plankton populations like the copepods, Veligers, phytoplankton and fish eggs. The copepod population has a minor peak at 8 a.m. and a major peak

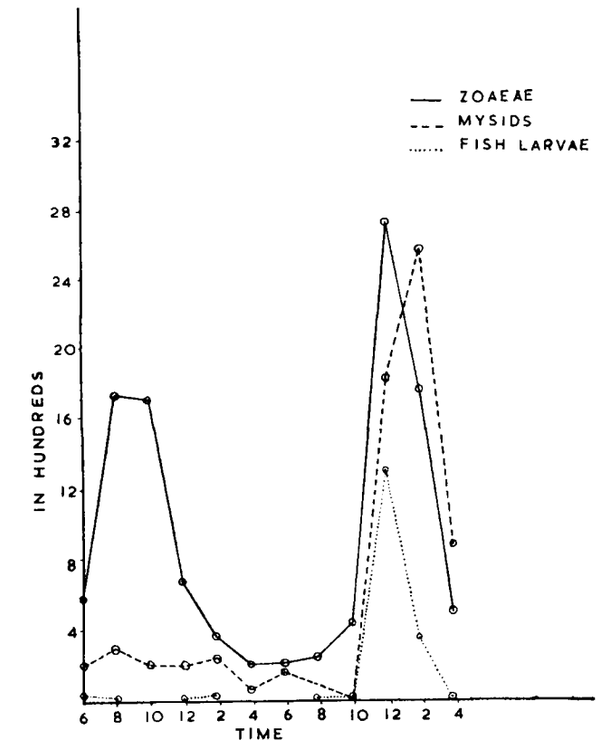


Graph 5. Graph showing two-hourly fluctuations in the population of Copepods, Veligers, phytoplankton and fish eggs, on 11th-12th April, 1956.
——— Copepods; - - - - Veligers; ..... phytoplankton; -.-.-. fish eggs.

at 12 midnight. It will be observed from the graph that after 4 p.m. and till 6 p.m. there is a steep rise, and then from 6 p.m. a gradual rise till about 10 p.m. and then a steep rise. After 12 midnight the decrease is sudden.

The veliger population shows a gradual rise from 6 a.m. onwards and has a minor peak at 12 noon. After 12 noon there is a decrease in population till 4 p.m. There is an increase in their members after 4 p.m. with a major peak at 12 midnight.

In the phytoplankton population there are two minor peaks at 10 a.m. and 6 p.m. and a major peak at 12 midnight.



Graph 6. Graph showing two-hourly fluctuations in the population of Zoeae, Mysids and fish larvae on 11th-12th April, 1956.
——— Zoeae; - - - - Mysids; ..... fish larvae.

Fish eggs which are very rare during daytime, as stated already, are common at night. There is a steep rise in their numbers from 8 p.m. to 12 midnight, and a steep fall from 12 midnight to 4 a.m. Few fish larvae are present during the day. The population of fish larvae shows a peak at 12 midnight (Graph 6).

The population of zoeae shows two major peaks, one at the time of the first high water (8 a.m.) and another at 12 midnight (Graph 6).

Mysids are present in small numbers in the day collections but show a steep increase from 10 p.m. onwards reaching a peak at 2 a.m. After 2 a.m. there is a steep fall in their numbers (Graph 6).

Summary

1. The paper records the preliminary observations on some of the hydrobiological variations during a diurnal tidal cycle in the Vellar estuary.
2. The tide in the Vellar estuary is of the semi-diurnal type having two high waters and two low waters each day. The evening high water is slightly higher than the morning high water.
3. The temperature cycle of the surface waters follows closely the cycle of air temperature. The range of variation in the temperature of surface water during one tidal cycle is 3.8°C.
4. The thermal stratification that is developed during the early part of the tidal cycle is short-lived and is destroyed at the commencement of second high water occurring in the evening
5. The concentration of oxygen in the surface layers follows closely the temperature cycle and reaches a maximum at 4 p.m., when the surface layer has the highest temperature.
6. The salinity of the water at the bottom is always higher than that of the surface water salinity, and a pronounced chlorinity conflict is established in the estuary at the time of low waters.
7. The plankton is poor in the surface waters of the estuary during daytime, but there is a great increase in the volume of plankton collected during the second low water at night. Numerous veligers of the bottom molluscan fauna, Decapod larvae and fish eggs are common in the plankton at night. Neritic planktonic organisms are common in the collection made during high tide.
8. The physico-chemical features as well as the plankton show a complex pattern of diurnal fluctuations. Further work is in progress.

Acknowledgements

I am thankful to Prof. R. V. Seshaiya, Director, Marine Biological Station, Porto Novo for suggesting the problem and for guidance.

TABLE 1—*Data relating to the tidal cycle in the Vellar estuary on 11—12 April, 1956.*

Time	Tide level	Air	Temperature C			Oxygen p.p.m.			Salinity per Thousand			Carbonate p.p.m.			Bicarbonate p.p.m.			Secchi disc reading in cm.	Plankton volume in cc.	Current velocity in meters per second		Direction of flow in the river
			Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom			Surface	Bottom	
6 a.m.	2'7"	27.2	28.7	28.6	28.8	5.4	5.0	5.6	26.96	30.69	31.67	10.0	10.0	10.0	40.0	32.0	38.0	48.0	16.0	0.227	0.250	Up
8 a.m.	3'9"	28.3	28.7	28.6	28.5	6.0	6.0	5.4	33.63	34.03	34.23	10.0	10.0	10.0	31.0	32.0	32.0	61.0	16.0	0.137	0.345	Up
10 a.m.	3'7"	29.4	29.8	28.7	28.6	5.6	6.4	4.2	31.87	33.45	33.63	0.0	12.0	8.0	44.0	32.0	39.0	81.0	10.0	0.280	0.036	Down
12 noon	2'7"	31.1	30.8	29.0	29.0	5.6	5.8	5.6	28.76	30.69	32.65	6.0	10.0	12.0	41.0	37.0	31.0	71.0	6.0	0.340	0.050	Down
2 p.m.	1'10"	31.1	32.5	29.2	29.6	6.2	6.6	4.2	26.37	29.71	32.17	4.17	4.0	4.0	13.0	12.0	12.0	68.0	4.0	0.220	0.047	Down
4 p.m.	1'7"	31.1	32.5	29.8	29.2	7.4	7.4	6.0	25.17	26.57	32.07	0.07	0.0	6.0	15 0	8.0	10.0	55.0	3.0	0.317	0.000	Down
6 p.m.	2'7"	30.6	32.0	32.1	32.0	6.2	6.4	5.6	32.47	33.63	33.83	2.83	2.0	6.0	8.0	8 0	12.0	36.0	10.0	0.100	0.205	Up
8 p.m.	3'7"	30.0	29.6	29.7	29.6	6.4	6.2	6.2	33.83	34.23	34.23	4.23	4 0	4.0	10.0	11.0	13.0	—	6.0	0.137	0.295	Up
10 p.m.	3'4"	29.4	30.5	29.9	29.7	6.2	6.0	5,8	33.05	33.25	33.45	3.45	4.0	6.0	8.0	6.0	8.0	—	10.0	0.235	0.045	Down
12 midnight	2'4"	28,9	30.6	31.2	30.2	6.4	5.8	4.8	26.17	29.51	32.07	0.07	0.0	4.0	4.0	9.0	10.0	—	60.0	0.455	0.027	Down
2 a.m.	1'6"	28.3	30.6	30.9	30.2	6.0	5.8	4.0	22.02	26.17	31.49	0.49	0.0	4.0	4.0	9.0	10.0	—	80.0	0.395	0.011	Down
4 a.m.	1'2"	27.8	30.8	30.8	31.0	4,8	5.6	4.0	20.43	25.58	32.07	0.07	0.0	4.0	4.0	9.0	9.0	—	38.0	0.300	0,039	Down
6 a.m.	2'3"	27.2	29,0	28.8	28.7	5.4	5.4	5.0	28.55	29.13	29.91	2.91	2.0	4.0	4.0	10 0	10.0	—	16.0	0.220	0.117	Up

08—41 hours } Low water 14—55 hours
20—40 hours } High water 03—02 hours

TABLE 2—*Data relating to the analysis of plankton collected at different intervals of the tidal cycle.*

	6 a.m.	8 a.m.	10 a.m.	12 noon	2 p.m.	4 p.m.	6 p.m.	8 p.m.	10 p.m.	12 mid-night	2 a.m.	4 a.m.
Copepods	1,352	2,976	1,888	1,440	1,344	1,200	10,624	11,104	11,904	15,936	7,104	3,280
Zoeae	592	1,744	1,728	696	376	216	224	256	2,448	2,752	1,760	512
Fish eggs	—	—	—	—	—	—	—	32	5,152	8,800	2,016	512
Fish larvae	32	16	—	16	40	—	—	2	5	1,313	355	16
Mysids	200	304	208	208	248	64	160	96	12	1,835	2,598	884
Veligers	304	624	784	1,464	656	168	800	3,136	2,496	4,512	3,648	1,584
Nauplii	48	96	16	32	16	32	32	—	224	64	80	96
Sagitta	24	16	32	—	—	—	215	152	108	102	23	32
Ascidian tadpole	16	64	32	—	—	—	—	96	64	32	48	16
Plychaete larvae	56	64	64	8	16	56	160	480	224	160	128	128
Phytoplankton	296	496	944	224	64	80	2,496	1,696	4,128	4,416	2,016	496
Diphyes	—	5	—	—	—	—	325	33	34	64	—	—
Medusae	—	—	96	—	—	—	28	74	13	90	—	—
Lingula larvae	—	32	16	8	8	—	32	—	—	32	80	16
Ctenophores	—	5	—	—	—	—	108	9	43	1	2	4
Cypris	—	—	—	—	—	—	96	96	64	64	—	16

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Morphology of Head Capsule and Mouth Parts of *Schizodactylus monstrosus* Don. (Orthoptera)

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(With 12 Text-Figures)

(Communicated by DR. M. L. ROONWAL, F.Z.S.I.)

CONTENTS

Introduction

Schizodactylus monstrosus is a pest of Maize and *Arhar* seeds. It also feeds on flesh. Tension (1912) while discussing the distribution of crickets, described that this insect has a wide distribution. Lefroy (1909) placed *Schizodactylus* in his sub-family Gryllacrinae and mentioned its occurrence in Bihar. Essig (1942) classified it in the family Stenopelmatidae and since then entomologists agree with Essig's classification.

The general anatomy of the head and mouth parts of the various members of the group Orthoptera and Euplexoptera has been described by Yuasa (1920). Davis (1927) described the anatomy and histology of the alimentary canal of *Stenopelmatus fucus* (Stenopelmatidae) and also made some general remarks on its head. According to this author *Stenopelmatus* is omnivorous and may eat flesh under laboratory conditions.

However, no detailed account of the head and mouth parts of the Stenopelmatidae is available. Present account is a detailed study of the morphology of the head capsule and mouth parts of *Schizodactylus monstrosus*.

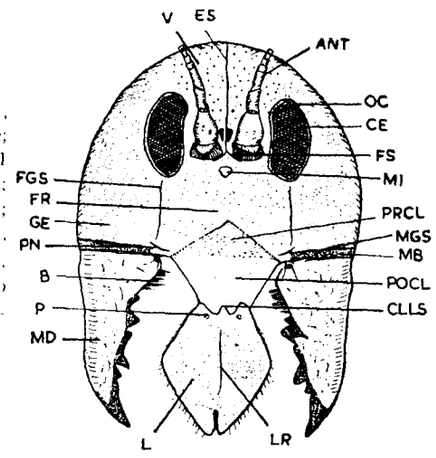
Meterial and Technique

The adult specimens of *Schizodactylus monstrosus* were collected from the banks of Anasagar and Foysagar Lakes, Ajmer. The head and mouth parts of the specimen were made transparent by treating them with 5% solution of potassium hydroxide for 15-24 hours. The various structures were studied with the help of a dissecting binocular microscope.

Head-Capsule

Head Capsule (Text-Figs. 1, 2 and 3)

The head capsule of *Schizodactylus monstrosus* occupies a horizontal position in front of the thorax and has hypognathous type of mouth parts. The mid-dorsal region of the head capsule, the epicranium, carries a median longitudinal suture, the epicranial or coronal suture which



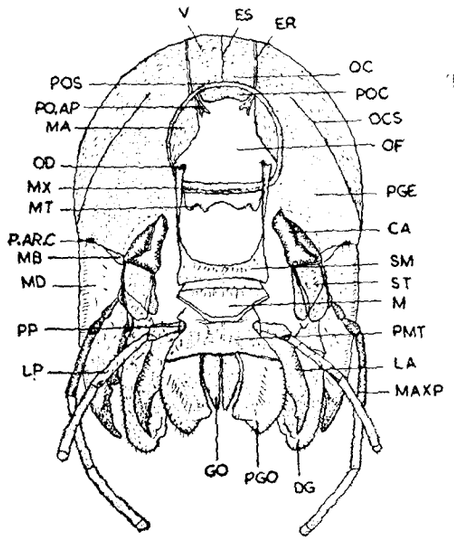
Text-Fig. 1. *Front view of head ant.*, antenna; *b.*, brustia; *ce.*, compound eye; *clls.*, clypeolabral suture; *es.*, epicranial suture; *fgs.*, frontogenal suture; *fr.*, frons; *fs.*, frontal suture; *ge.*, gena; *l.*, labrum; *lr.*, labral ridge; *mb.*, mandibularia; *md.*, mandible; *mgs.*, mandogenal suture; *mi.*, muscle impression; *oc.*, oculata; *p.*, group of papillae; *pn.*, pretentorina; *pcl.*, preclypeus; *pocl.*, postclypeus; *v.*, vertex.

divides anteriorly into two branches, the frontal sutures. On either side and parallel to the epicranial suture on the ventral side of the head are two ridges, the epicranial ridges, which become indistinct on the anterior side. Yuasa (1920) while describing in general the anatomy of the head and mouth parts of the group Orthoptera and Euplexoptera did not mention the presence of the epicranial ridges in any of the members.

The area in front of the frontal sutures is known as frons or front, while the area behind these sutures and extending to the ventral surface of the head is the vertex. Just caudad of bifurcation there are two raised oval chitinous areas one on each side of the epicranial suture. A large number of small papillae are present on the dorsal side of the vertex.

The frons, a conspicous part of the head is raised at its extremities and is bounded dorsally by the frontal sutures and compound eyes, laterally by the fronto-genal or sub-ocular sutures and posteriorly the boundary is indefinite as there is no epistomial suture between it and the clypeus.

In *Schizodactylus monstrosus* the antennae are located on the vertex because of the position of the frontal sutures. This is a peculiar feature in this species as in other members of the group the antennae are located on the frons (Yuasa, 1920). Each antenna is lodged in a membranous circular area, the antacorium which is surrounded by a chitinous ring, the antennal sclerite or antennarium. The scape, which is the first segment, is a strongly built piece and articulates with the rim of the antennal sclerite at two points, the latero-dorsal and the meso-ventral. The latero-dorsal articulation consists of a basal process of the scape, the antartis (Yuasa, 1920) hinged with the dorsolateral corner of the rim of the antennal sclerite, while the mesoventral articu-

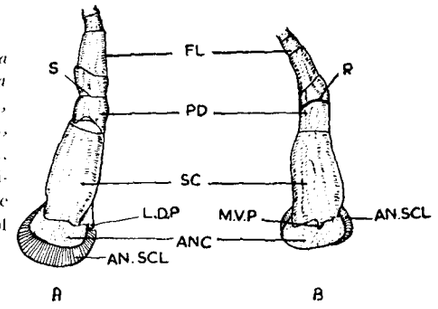


Text-Fig. 2. *Back view of head ca.*, cardo; *dg.*, distigalea; *er.*, epicranial ridge; *cs.*, epicranial suture; *gl.*, glossa; *la.*, lacinia; *l.p.*, labial palpus; *m.*, mentum; *ma.*, macrocoxita; *max.p.*, maxillary palpus; *mb.*, mandibularia; *md.*, mandible; *mt.*, metatentoria; *mx.*, maxillaria; *oc.*, occiput; *ocs.*, occipital suture; *od.*, odontoidea; *of.*, occipital foramen; *p.ar.c.*, posterior articular condyle; *pgc.*, postgena; *pga.*, paraglossa; *pmt.*, prementum; *po.ap.*, postoccipital apodeme; *poc.* postocciput; *pos.*, postoccipital suture; *pp.*, palpiger; *sm.*, submentum; *st.*, stipes; *v.*, vertex.

lation formed by the ventro-mesial side of the scape does not reach upto the rim of the antennal sclerite. Only because of the attachment of meso-ventral antatendon (Misra, 1945), the latter process has been considered as an articulatory process of the scape though it does not reach the rim of the antennal sclerite. The antacorium facilitates the dorso-ventral movement of the scape between the two articulatory points. The pedicel, the second segment of the antenna is divided into two segments by a suture on the dorsal side with a corresponding ridge on the ventral side, and is longer than its breadth. It carries a dicondylic articulation to the scape with a membranous ring at the base which facilitates

its movement. Two antatendons, the laterodorsal antatendon and the mesoventral antatendon are attached to the respective articulatory points of the scape. A unique feature in this insect is the additional presence of two short antatendons attached to the two articulatory points of the pedicel. The flagellum is composed of many segments (of which the first being longest) which are immovably connected with each other.

The area on each side of the epicranial suture is named as the parietal region (Crampton, 1921). In the antero-mesial corners of the parietal region are situated two large compound eyes. Each eye is large & kidney-shaped and located within a chitinous ring, the oculata. The lateral ocelli are absent but a single muscle impression on the frons below frontal sutures presents an appearance similar to a median ocellus (Karandikar, 1939).



Text-Fig. 3. A. *The base of antenna (Dorsal view)* B. *The base of antenna (Ventral view) ant.*, antacorium; *an.scl.*, antennal sclerite; *fl.*, flagellum; *l.d.pr.*, latero-dorsal articular process; *m.v.pr.*, meso-ventral articular process; *pd.*, pedicel; *r.*, ridge on the ventral side of the pedicel; *s.*, suture on the dorsal side of the pedicel; *sc.*, scape.

The lateral area of the head—the gena (Snodgrass, 1935) is limited anteriorly by the fronto-genal suture, ventrally by the mandogenal suture and posteriorly by the occipital suture.

On the dorsal surface of the head forming the caudal margin of each mandibularia on each side and separating it from the gena and frons is the mandogenal suture which is well developed in this insect in comparison to that of other members of the group. Extending from the caudal margin of each mandibularia is a linear furrow, the pretentorina, leading to the anterior arm of the tentorium.

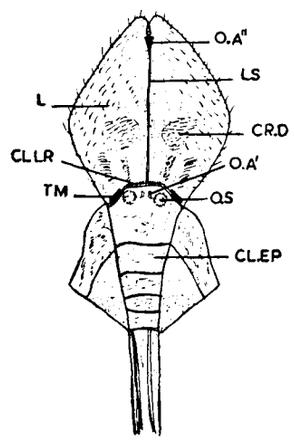
The caudal end of the head on the ventral aspect is formed by a large occipital foramen. Surrounding the caudal one-third of the occipital foramen is a semicircular area, the occiput, the exact boundaries of which are not definite, as there is no suture either on its caudal margin where it meets the vertex, or on its cephalic margin where it merges with the postgena. The imaginary line drawn across the occipital foramen just cephalad of the odontoideae is considered as the cephalic limit of the occiput. The rest of the occipital foramen on either side is surrounded by a broad postgena whose lateral margins are limited by the occipital sutures which run on the ventral side of the head

and have their caudal ends free. Posterior to the occiput and surrounding the occipital foramen is a small sclerite, the post occiputs separated from the occiput and postgena by a postoccipital suture. At the ventral extremity of this suture on eiher side is situated an open pit, the metatentorina which leads to the posterior arm of the tentorium. Lateral and below each end of the postocciput is a large chitinous plate, the macrocoria, between which and the postocciput on either side is present a broad postoccipital apodeme directed cephalad. The submentum is attached to the head capsule by means of two elongated plates, the maxillariae. Each maxillaria runs from the caudal end of the submentum to the base of macrocoriae and develops a rounded condyle at its caudal end, the odontoid process (Yuasa,1 920)or occipital condyle (Crampton, 1921).

Mouth-Parts

CLYPEO—LABRUM (Text-Figs. 1 and 4).

A cuticular clypeo-labrum, convex dorsally and concave ventrally, hangs vertically downwards from the frons between the two mandibles and occupies a mesial area of the mouth. The absence of the epistomial suture joins the frons and clypeus into a fronto-clypeus. The clypeo-labrum consists of a clypeus above and a labrum below, movably articulated with each other by a clypeo-labral suture on the anterior side



Text-Fig. 4. *The clypeo-labrum (Posterior view) cl.ep.*, clypeal epipharynx; *cllr.*, clypeo-labral ridge; *cr.d.*, crescentis depression; *l.*, labrum; *lbs.*, labral suture; *o.a.'.,o.a.''.*, opague areas; *o.s.*, oral sense organ; *tm.*, torma.

and the clypeo-labral ridge on the posterior side. The mobility of the labrum is increased by presence of a deep square cavity in the middle of the clypeo-labral suture. The clypeus and labrum are made up of two closely apposed walls, a thick anterior and a membranous posterior (the labral and clypeal epipharynx).

The clypeus is differentiated into an upper pre and a lower post-clypeus with a difference in the consistency of the two parts; such a

condition is supposed to be primitive (Walker, 1931). At each dorsolateral corner the clypeus is produced into a notch, the precoila into which fits the anterior articular process of the mandible of the same side. The clypeal epipharynx is divided into six segments by transverse grooves; two longitudinal grooves also run towards the pharynx.

The sub-rhomboid labrum bears a median notch on its free lower border which gives it a bilobed appearance. Anteriorly the labrum is separated from the clypeus by a three-rayed clypeo-labral ridge on the posterior surface. The middle arm of the clypeo-labral ridge is beset with numerous papillae and runs horizontally while the two lateral arms are at an angle of 60 degrees to the middle arm and are directed backwards. On the anterior plate of the labrum and at the base of it are present two groups of small papillae. A median longitudinal suture, the labral suture runs on the posterior side of the labrum from the upper end of the notch to the lower side of the clypeo-labral ridge and corresponds with a short ridge on the anterior side. Just in the middle on either side of the labral suture are two large shallow crescentic depressions for the insertion of muscles. Short and long pointed bristles surround the margins of these depressions. At the sides of the lateral arms of the clypeo-labral ridge are two small chitinous structures, the tormae. The lateral margins of the labrum are entire, sclerotised and bear short bristles pointing outwards. The whole of the labral epipharynx is beset with long and short bushy bristles.

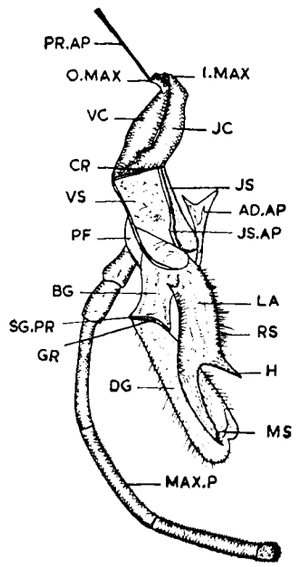
MAXILLAE (Text-Fig. 5)

The maxillae lie just behind the mandibles, one on each side of the mesially placed labium and each articulates with the ventral margin of the postgena by means of two processes of the cardo which work against the corresponding grooves in the postgenal margin. Each maxilla consists of four parts, proximally the cardo and the stipes and distally the galea and the lacinia.

The cardo to some extent is rhomboid in shape. A longitudinal ridge running from the anterior end and ending just near the lower left corner divides the cardo into two parts, the inner juxtacardo and the outer veracardo. The juxtacardo at the anterior end forms the inner articular process. The veracardo forms an outer articular process which is situated below the inner articular process and is shaped like the handle of a walking-stick. From the outer articular process is given off a long promotor apodeme for the insertion of muscles.

The stipes is a quadrate structure separated from the cardo by a cardostipital suture on the anterior side and the cardostipital ridge on the posterior side. The stipes is composed of three pieces, (i) a narrow inner racket-shaped piece, the juxtastipes, (ii) a broad rectangular

middle piece, the verastipes and (iii) an outer piece, the palpifer which is not distinctly seen from the anterior view. The juxtastipes is separated from the verastipes by a ridge all along its length. Near its broader end the ridge invades the verastipes and is produced into a strong juxtastipital apodeme. At the outer end of the juxtastipes is given out another apodeme with a long narrow process towards the juxtacardo. the adductor apodeme. The palpifer is a small sclerite near the cephalolateral part of the verastipes and is separated from it by a ridge running from the outer end of the cardostipital ridge to the distal end of the palpifer.



Text-Fig. 5. *The right maxilla (Anterior view) ad.ap.*, adductor apodeme; *bg.*, basigalea; *cr.*, cardostipital ridge; *dg.*, distigalea; *gr.*, galeal ridge; *h.*, hamadens; *i.max.*, inner articular process; *js.*, juxtacardo *js.*, juxtastipes; *js.ap.*, juxtatipital apodeme; *la.*, lacinia; *max.p.*, maxillary paipus; *ms*, maxadentes; *o.max.*, outer articular process; *pf.*, palpifer; *pr.ap.*, promotor apodeme; *rs.*, lacinarastra; *sg.pr.*, conical process of subgalea; *vc.*, veracardo; *vs.*, verastipes.

From the outer border of the verastipes are given out the outer galea and the mesial lacinia. The galea is divided into two parts by a galeal suture on the posterior side with the corresponding ridge on the anterior side. The lower part, the subgalea is short, sclerotised and with a conical subgaleal process at the outer end. The distigalea is a large membranous lobe widened distally and overtops the lacinia. It bears long bristles on its inner and outer margins and small setae on the anterior side of the upper half portion where it shows a sign of bifurcation by a small notch. The suture between the subgalea and the stipes is indistinct on the posterior side.

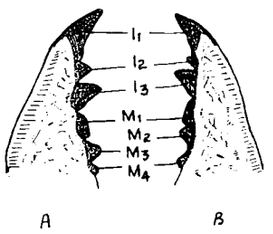
The lacinia is a hook-shaped, depressed, chitinous and dentate structure; its surface and mesial margins are convex but the lateral half of the proximal part is concave dorsally. The lacinia of each side has two maxadentes and a hamadens. The second maxadentes of

right maxilla has a short conical tooth-like projection at its base which looks like a third maxadentes. The maxadentes and hamadens are sharp, strongly chitinised and inwardly directed teeth widely separated from each other. On the inner proximal margin the lacinia carries many stiff long hair, the lacinarastra directed towards the preoral cavity. The suture between the lacinia and stipes is indistinct on the anterior side.

The palpifer appears more or less like basal segment of the palpus, bears a five segmented maxillary palpus. The proximal segment of the palpus is small and cylindrical. The second segment is longer than the first, and the third is long and cylindrical while the fourth and fifth are subequal in length. The distal end of the fifth segment is covered with numerous setae having a gustatory function (Crampton, 1916).

MANDIBLES (Text-Figs. 2, 6, 7, 8 & 9).

The mandibles lie at the sides of the clypeus. Each mandible is a long strongly cuticularised subconical structure with a broad triangular base and a pointed apex. The inner cutting margin of each mandible is differentiated into strongly cuticularised teeth which can

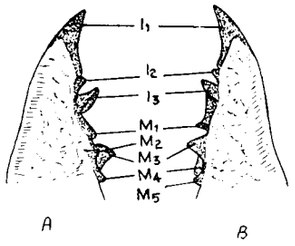


Text-Fig. 6. A. *The cutting margin of left mandible (Anterior view)* B. *The cutting margin of left mandible (Posterior view)* i_1, i_2, i_3, i_4, etc., first, second, third, fourth etc. incisor; m_1, m_2, m_3 etc. first second, third etc. molars.

be distinguished into lower cutting incisors and the upper grinding molars. The number and arrangement of the incisors and molars is neither similar nor symmetrical on the right and left mandibles. The cutting margin of the left mandible has three incisors and five molars while the cutting margin of the right mandible has three incisors and only four molars.

In the left mandible the first incisor is very long (3.5 mm.) pointed at the apex and directed outwards. On its anterior surface is a depression which differentiates it into two parts, the lower pointed and the upper broad respectively. The second incisor is sharp with a pointed cusp and lies at the base of the first incisor. The third incisor is long, straight and directed inwards with a single pointed cusp and a broad base. At an angle of 60 degrees to the third incisor is the first molar directed inwards and bears a blunt cusp. The second and third molars are long, the third being longer than the second. The former

is a pointed cusp while the latter with a blunt cusp. The two cusps lie opposite to each other in the same horizontal plane. The fourth and fifth molars are short with blunt cusps. The fifth molar lies behind the fourth and is not visible in the anterior view. The two cusps of



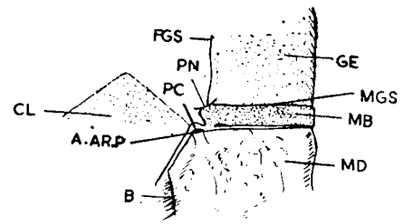
Text-Fig. 7. A. *The cutting margin of right mandible (Anterior view)* B. *The cutting margin of right mandible (Posterior* view).

Lettering as in Fig. 6.

the fourth and fifth molars also lie opposite to each other in the same horizontal plane. The last four molars lie in two arcs at an angle of 60 degrees to each other and are arranged in such a way as to form a four-cusped tooth with a cavity between them.

The first incisor of the right mandible directed outwards, is also very long (3 mm.) pointed at the apex and ends bluntly at the broad base. Two depressions are visible on its anterior margin, which divide it into three parts, the lower, the middle and the upper part respectively. At the base of the first incisor lies the second incisor which is short and has a pointed cusp. The third incisor is also long

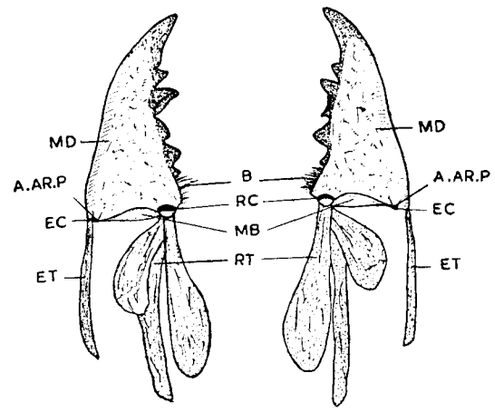
Text-Fig. 8. *Basal region of the mandible showing its anterior articulation. a.ar. p.*, anterior articular process; *b.*, brustia; *cl.*, clypeus; *f.gs.*, fronto-genal suture; *ge.*, gena; *mb.*, mandibularia; *md.*, mandible; *mgs.*, mandogenal suture; *pc.*, precoila; *pn.*, pretentorina.



with a pointed cusp and is directed inwards and outwards. Out of the four molars the first is peculiar of all. It is short and has the cutting margin in the form of an edge of a glass-plate. The second molar is long with a blunt cusp and a broad base. It is directed inwards and is not visible in the posterior view. The third molar is shorter than the second, bears a blunt cusp and is directed inwards; while the fourth molar with a blunt cusp is shortest of all. The last three molars are arranged to form a tricuspid tooth with a cavity between them.

The peculiarity about the mandibles of this insect is that the incisors and molars in both the mandibles are all single cusped.

Each mandible has two articulatory processes at its proximal end, an anterior and a posterior articulatory process. The anterior articular process fits into the precoila while the posterior articulatory process bears a well developed condyle which fits into a cavity formed in the lower lateral margin of the postgena. Between these articulatory processes intervenes a rectangular strip of cuticle, the mandibularia.



Text-Fig. 9. *The left and right mandibles with their tendons. a.ar.p.*, anterior articular process; *b.*, brustia; *cc.*, extensacuta; *et.*, extensotendon; *mb.*, mandibularia; *md.*, mandible; *rc.*, rectacuta; *rt.*, rectotendon.

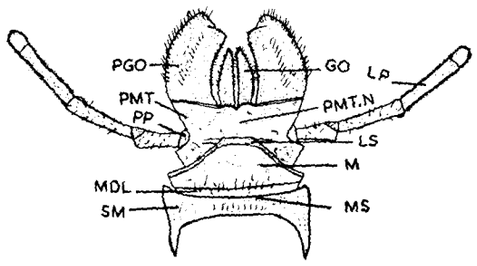
Along the base of the molar region are situated many long stiff hairs, the brustia which are directed towards the preoral cavity and are useful in preventing the escape of the masticated food material (Snodgrass, 1928).

The base of each mandible possesses two apodemes for the insertion of mandibular muscles. A small spatulate extensotendon is attached near the posterior articular process and a large branched rectatendon is attached to the proximal part of the mesial margin on the ventral aspect. The base of the rectatendon is chitinized and forms the rectacuta while that of the extensotendon forms the extensacuta.

LABIUM (Text-Figs. 10-a & 10-b).

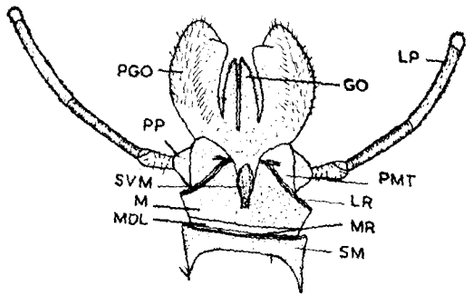
The labium is situated between the mandibles and forms the floor of the preoral cavity. It is, like the labrum, composed of two closely apposed walls, which though fused along their entire margin have the remaining area free from each other. The posterior wall is sclerotised while the anterior is membranous. The labium is formed of submentum, mentum, prementum, and ligula which includes glossae, paraglossae, palpigers and labial palpi.

The submentum is a wide narrow sclerite. It has a crescentic dorsal margin held between the widely produced dorsolateral arms by which it is attached to the ventromesial margin of the postgena. The submentum is separated from the mentum by a well developed mental ridge on the anterior side and a mental suture on the posterior side. Cephalad to the submentum is a narrow flexible area, the midlabium (Crampton, 1928) which separates the mentum from the submentum.



Text-Fig. 10. A. *The Labium (Anterior view)*. *go.*, glossa; *l.p.*, labial palpus; *lr.*, labial ridge; *ls.*, labial suture; *m.*, mentum; *mdl.*, midlabium; *mr.*, mental ridge; *ms.*, mental suture; *pgo.*, paraglossa; *pmt.*, prementum; *pmt.n.*, premental notch; *pp.*, palpiger; *sm.*, submentum; *sem.*, salivarium.

The mentum is a broad, transverse and distinct sclerite marked off from the prementum by a well developed labial ridge on the anterior side and the labial suture on the posterior side. The labial suture becomes more wide mesially and gives out lateral extensions on either side.



Text-Fig. 10. B. *The Labium (Posterior view)*. Lettering as in Text Fig. 10 A.

The prementum is a broad sclerite presenting a paired appearance on account of a deep median notch, the premental notch which extends into it from its outer border. Posteriorly the prementum bears a palpiger on either side.

Each palpiger is a small sclerite located on the lateral side and bears a three segmented labial palpus.

The free end of the prementum bears a pair of membranous glossae and paraglossae. Each glossa and paraglossa is separated from the prementum by a transverse ridge running at their bases. The ridge may also be an indication of the suture which separates the paraglossa into two segments—a condition comparable to the two segmented galea of maxilla (Yuasa, 1920). The glossae are well developed, pointed and placed symmetrically between the two long paraglossae. Each

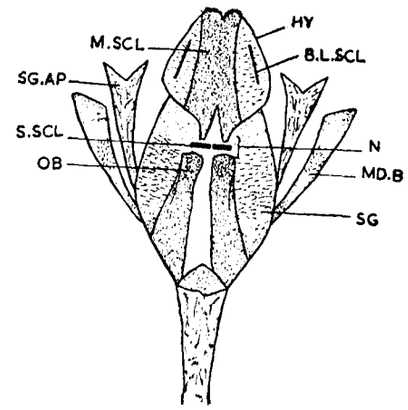
glossa is beset with short and pointed bristles on its lateral and anterior margins. The mesial or dorsal portion of each paraglossa is concave and overlaps the glossa to a greater extent. Each paraglossa bears long bristles on the lateral margins. The anteroir and posterior surfaces also bear two linear rows of long pointed bristles.

Each labial palpus is three segmented and geniculate. The basal segment is the smallest and bears few scattered pointed bristles. The middle segment is smaller than the third which is long, cylindrical, elevate and with a spherical membranous tip covered with minute setae.

The inner surface of the labium has a membranous lining which in its mesial region is inflected to form a shallow depression, the salivarium over the mesoventral region of the hypopharynx. At the point of junction of the hypopharynx to the labial sheath is situated the opening of the salivary duct.

HYPOPHARYNX (Text-Fig. 11).

The hypopharynx which forms the floor of the oral cavity is well developed in *Schizodactylus monstrosus*. It is made up of two closely apposed walls, the anterior membranous and the posterior sclerotised.



Text-Fig. 11. *The Hypopharynx (Anterior view)* *b.l.scl.*, basal lateral sclerite; *hy.*, hypopharynx proper; *md.b.*, mandibular bar; *m.scl.*, middle sclerite; *n.*, neck; *o.b.*, oral bar; *sg.*, subgusta; *sg.ap.*, subgustal apodeme; *s.scl.*, suspensorial sclerite.

It is distinguishable into three parts, (i) the proximal subgusta by means of which it is attached to the mentum and maxillae, (ii) the middle neck and (iii) the distal hypopharynx proper.

The subgusta forms the floor of the mouth and the cibarium. Its lateroventral walls are supported by a pair of transparent cuticular sclerites, the mandibular bars having short and pointed bristles on their dorsal surfaces. Laterad and mesiad of each mandibular bar is another broad brown sclerite, the oral bar which supports the middle part of the

subgusta. Arising from the lateral wall of the subgusta and between it and the mandibular bar on either side is the membranous apodeme, the subgustal apodeme. Lateral and outer to each oral bar the subgusta bears a large number of inwardly directed and thickly set bristles on its dorsal surface.

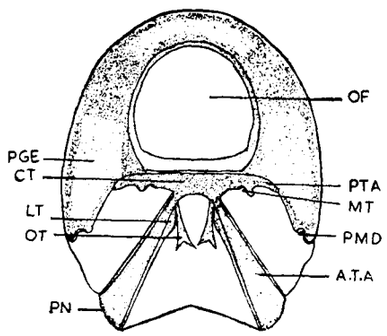
The neck situated in front of the subgusta is short and is supported on each side by a chitinous darkly coloured rectangular bar known as the suspensorial sclerite.

The distal portion—the hypopharynx proper, is a free lobe bifurcated at its lower border by a notch. Each lobe is supported on its lateral side by a long, slender and chitinous sclerite, the basal lateral sclerite. The middle portion of the hypopharynx is supported by a single broad brown sclerite, the middle sclerite which also supports the salivos. The tips of the lobes are fringed with small sensory hair. The dorsal surface of the hypopharynx proper is bordered on each side by numerous inwardly directed and thickly set bushy bristles. The basal portion of the hypopharynx projects towards the neck and forms the salivos which fits into the salivarium.

Tentorium

TENTORIUM (Text-Fig. 12)

The tentorium is endoskeleton of the head capsule. It is thick and heavily chitinized in *S. monstrosus* and consists of the following sclerites: (i) the carpotentorium; (ii) the anterior tentorial arms and (iii) the posterior tentorial arms.



Text-fig. 12. *The tentorium and the part of the head capsule attached to it (Anterior view). a.t.a.*, anterior tentorial arm; *ct.*, carpotentorium; *lt.*, laminotentorium; *mt.*, metatentorina; *of.*, occipital foramen; *ot.*, oesotendon; *pgc.*, postgena; *p.md.*, posterior articulation of mandible; *prc.*, pretentorina; *p.t.a.*, posterior tentorial arm.

The carpotentorium is the large posterior part of the canopy of the tentorium and is formed by the fusion of the two posterior tentorial arms mesially. It lies between the two postgenae and forms the cephalic margin of the occipital foramen.

From each anterolateral corner of the canopy of the tentorium is given out an anterior tentorial arm which is narrow at its base but broadens out distally to meet the anterior wall of the head just above

the anterior articulatory process of the mandible. Each anterior tentorial arm which is triangular in outline opens to the exterior by a transverse linear pit, the pretentorina. The outer and inner borders of the triangle are thickly cuticularized while the connecting membranous part between them is flat dorsally and slightly concave ventrally. A plate-like projection is present on the dorsomesial side of each anterior tentorial arm. This plate represents the rudiment of the laminotentorium. From the ventral side of each anterior tentorial arm is given out a large apodeme, the oesotendon which runs in the ventral direction.

The posterior tentorial arms arise from the lateral sides of the carpotentorium and meet laterally with ventral margins of the postgenae. A single pit, the metatentorina in the mesoventral corner of the postgena indicates the point of attachment of the posterior tentorial arm to the ventral wall of the head.

Acknowledgments

I am grateful to Dr. P. N. Mathur for his kind guidance and supervision. I am also thankful to Principal Bhim Sen for providing me the Laboratory facilities. My thanks are also due to the Rajasthan Government for the grant of Research Scholarship.

Summary

A complete account of the external morphology of the headcapsule and mouth-parts is given.

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Address of the President

TO THE GENERAL MEETING OF THE ZOOLOGICAL SOCIETY OF INDIA
HELD AT MADRAS ON THE 7th JANUARY, 1958

BY M. L. ROONWALL
President, Zoological Society of India

CONTENTS

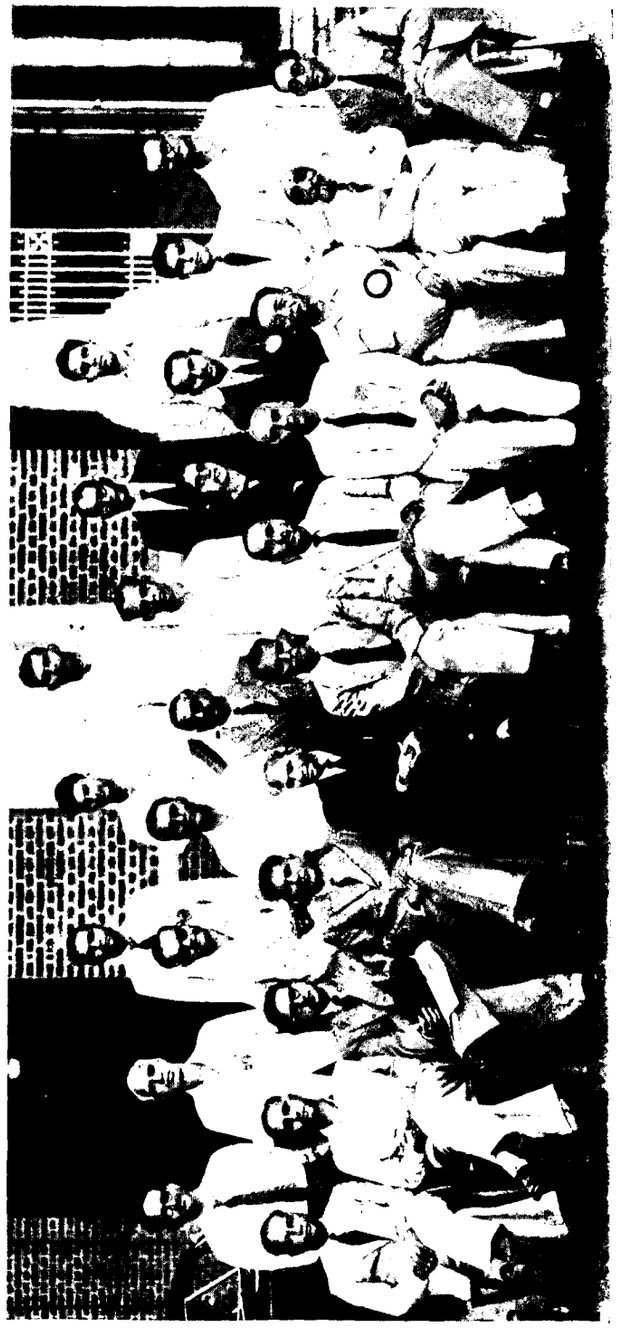
PART 1

THE PROGRESS OF THE SOCIETY DURING 1957

General

First of all, allow me to thank you and all other members for placing your confidence in me by electing me as your President for a term of two years. With the co-operation and goodwill of all of you, I hope to do my utmost for the well-being of the Society. May I also take this opportunity of wishing all of you A Happy New Year.

JOURNAL OF THE ZOOLOGICAL SOCIETY OF INDIA Vol. X, No. 1 (1958)



GROUP PHOTOGRAPH OF MEMBERS
taken after the Annual General Meeting at Madras, on 7th January, 1958.

Left to right :
First row (sitting) : 1. Dr. P. N. Ganapati (*Secretary-General*), 2. Dr. S. Jones, 3. Dr. B. L. Kaw, 4. Dr. B. S. Chauhan (*Treasurer*), 5. Dr. B. S. Bhimachar, 6. Prof. R. V. Seshaiya (*Editor*), 7. Dr. M. L. Roonwal (*President*), 8. Dr. H. S. Rao (*Vice-President*), 9. Prof. C. J. Shen (Delegate of China to 45th Session of Indian Science Congress), 10. Dr. G. S. Thapar (*Vice-President*), 11. Dr. B. C. Mahendra.
Second row (standing) : 12. Shri Chandy Kurian, 13. Shri G. Mathai, 14. Dr. B. Biswas, 15. Dr. K. C. Bose, 16. Shri V. Thirumala Rao, 17. Shri T. Desi Raju, 18. Dr. (Miss) V. R. Meenakshi, 19. Shri P. J. Sanjiva Raj, 20. Shri T. N. Ananthakrishnan, 21. Dr. G. Seshappa.
Third row (standing) : 22. Shri R. Nagabhushanam (*Assistant Secretary-General*), 23. Shri M. V. Lakshamana Rao 24. Dr. B. K. Behura 25. Dr. H. C. Rav, 26. Shri P. C. George.

To the retiring President, Dr. H. Srinivasa Rao, I would take this opportunity of expressing our thanks for steering the Society's ship in difficult waters during the two years of his stewardship. To the other retiring office-bearers also I would like to express our thanks for the work they did. To the new office-bearers I accord a hearty welcome, and I look forward to working with them as a team.

Membership

(a) *New additions*

The effective membership of the Society stands to-day at 146. Of these, 52 are Life Members and 56 Ordinary Members; and 38 are Fellows. Twenty-six new Members joined the Society during 1957 and we welcome them to our fold.

You will agree that our membership is not satisfactory, considering that ours is an All-India body, and I would request all members to do their utmost to raise the numerical strength of the Society. I feel that a membership-drive is necessary. This matter was discussed and certain decisions taken at the meeting of the Executive Council held on the 11th May, 1957, and I would now request the Secretary and the Treasurer to give effect to those decisions as early as possible.

(b) *Deaths*

I regret to record the death, on the 6th of April, 1957, of a valuable Fellow Dr. B. K. Das (of Hyderabad), and would request you to express our sorrow at the loss by rising in your seats for a minute.

Finances

The finances of the Society show a book-deficit of Rs. 5640-95 nP. and I would urge upon all members to make earnest efforts to increase the Society's membership and thus assist in increasing our finances. I am glad to say, however, that, thanks to the care of our Treasurer, Dr. B. S. Chauhan, the Society's bank balance to-day stands at Rs. 78,767/-, out of which the Permanent Funds in cash alone stand at Rs. 25.969/- (face value). The income of the Society during the portions of the financial year 1957-58 up to 30th November, 1957 was Rs. 5,759-10 nP. and the expenditure Rs. 2,622-40 nP., leaving a book-deficit of about Rs. 5,649-95 nP.

The following general donations were received during the year, and I would take this opportunity of thanking the donors, on behalf of the Society, for their generosity:—

(i)	Indian Council of Agricultural Research (1955-56):	Rs. 1,045/-
(ii)	Government of Bihar	1,000/-
(iii)	Travancore University	100/-
(iv)	Annamalai University	50/-

Applications for financial grants.—As in previous years, the Treasurer has made, on behalf of the Society, applications to various bodies for financial grants. A special feature of this application this year was that the Government of India has been approached for a grant of Rs. 15,000/- for holding the proposed First All-India Congress of Zoology under the auspices of the Society.

For further details about our finances, I would refer you to the Report of the Treasurer.

Revision of the Constitution

The revision of the Society's Constitution has been engaging the attention of the sucessive meetings of the Executive Council and the General Body for some years now. A thoroughly revised Constitution has been prepared this year. It has already been circulated to all the members and will come up for consideration before you in due course.

Publications

(a) *Publication of the "Journal"*

The second issue of the *Journal of the Zoological Society of India* for the year 1956 (Vol. 8, No. 2) was due to come out in December 1956 under the editorship of our former Editor, Dr. M. L. Bhatia, with Dr. M. Chandy as the Manager of Publications. Unfortunately this issue has not yet come out, but we expect that it may come out soon. Our new Editor, Prof. R. V. Seshaiya, started with a nil balance as far the manuscript of papers for publication in the current issues (Vol 9, Nos. 1 and 2) was concerned. It is, however, gratifying to record that he has been able to obtain papers, edit them and make them almost press-ready. The manuscript for both these issues will go to the press shortly. The manuscripts for Vol. 10, No. 1 (for 1958) are now in the hands of the Editor and it is expected that very soon we will clear up our arrears and become up-to-date in bringing out the various issues of the Journal.

(b) *The year-book*

The proposal to publish an *Year-Book* of the Society has been under consideration since 1953, but for long no appreciable progress was made. The matter was again discussed at the meeting of the Executive Council held in Calcutta on the 11th May, 1957, and it was decided to expedite the publication of the Year-Book. I am glad to say that due to the efforts of the Secretary and the Treasurer, the first *Year-Book for* 1956-57 was published last month and despatched to members. I hope it is already in your hands.

(c) *The "Indian Zoological Memoirs"*

The idea of having a series of Zoological Memoirs under the auspices of the Zoological Society of India was mooted early in 1953. Consultations were held by the then President and Secretary of the Society with the late Professor K. N. Bahl of Lucknow, who was the Founder-Editor of the series "Indian Zoological Memoirs" in which, since 1924, he had brought out eigth volumes some of them having run into several editions. Professor Bahl agreed that the series started by him may be taken over by the Society, but pointed out that due to failing health and other preoccupations he would not be able to edit the series in future. He, however, agreed to edit a revised edition of his own Memoir (No. 1, on *Pherctima*) and also No. 2 on *Scoliodon* by Dr. Thiliampallam). He further pointed out that he had already recently edited the Memoir No. 9 under the series, on The Indian Sting Ray, *Dasyatis*, by Dr. M. Chandy, which was waiting to be sent to the press. The arrangements for the printing of the memoir on *Dasyatis* were assigned in 1954 to Dr. M. L. Bhatia who was then the Manager of Publications of the Society. This memoir has now (1957) come out, but unfortunately not as Memoir No. 9 in the "Indian Zoological Memoirs" series under the auspices of the Society, but as Memoir No. 1 under a *new series*, designated as "Memoirs on Indian Animal Types", and initiated by Dr. M. L. Bhatia under his own Editorship without the Society's authority.

In spite of the fact that the Executive Council of the Society had taken a decision on the matter as early as January 1955, and both the Council and the General Body at the subsequent Annual Meetings in January, 1956, and January, 1957, had reiterated and amplified the decisions regarding these Memoirs, no progress was registered. The matter was again considered at the meeting of the Executive Council held in Calcutta on the 11th May, 1957, when a three-member *Indian Zoological Memoir Committee* of the Society was constituted consisting of Prof. R. V. Seshaiya, Prof. P. N. Ganapati and Dr. B. S. Chauhan (Convener). I am glad to say that, thanks to the members of this Committee, particularly of the Convenor, considerable progress has been made. Authors of three of the old Memoirs have agreed to have their respective memoirs published by the Society, and the latest position is as follows:—

(i) Memoir No. 2 (on the shark *Scoliodon*) by Dr. M. Thillayampalam. The author has agreed to revise the memoir and bring out the revised 5th edition under the auspices of the Society soon.

(ii) Memoir No. 6 (on the prawn, *Palaemon*) by Dr. S. S. Patwardhan. With the consent of the author, the memoir is being revised and reprinted and is already in the page-proof stage. An advance bound copy is now before you. The memoir is expected to be on sale in about a month's time.

(iii) Memoir No. 7 (on the Echinoid *Salmacis*) by Prof. R. Gopala Aiyar. The author has agreed to place the memoir entirely at

the Society's disposal and also generously agreed to give all the profits to the Society. At the author's suggestion and with his consent, the memoir is now being revised by our Secretary, Prof. P. N. Ganapati.

Thus, by the time we meet next we hope to have the satisfaction of seeing all the three memoirs in print. Steps have also been taken to bring out new monographs and negotiations are under way with a number of prospective authors. Rules and conditions to regulate the relationships of the authors, of both the old and the new memoirs, with the Society in regard to such matters as copyright, profits, etc., are also being framed.

The Society had decided in 1955, with the approval of the General Body, to constitute a special fund of Rs. 10,000/- for the publication of the Indian Zoological Memoirs". I am glad to say that the Treasurer has so far been able to place a sum of Rs. 5,600/- in that fund.

(d) *A "Who's Who" of the Members of the Society.*

The decision to prepare a *Who's Who* of the members of the Society was taken four years ago (in 1954), but no appreciable progress has been made It has been decided to intensify efforts in that direction and it is hoped that all the members will kindly co-operate by sending the required information at an early date.

Preparation of a National Register of Zoologists in India

The Society has decided to prepare a "National Register of Zoologists in India", and I hope that with the co-operation of all concerned, our Secretary will be able this year to complete such a Register for publication.

The First All-India Congress of Zoology

The desirability of holding periodically, say every four or five years, an All-India Congress of Zoology, will be appreciated by all members, and the Society has decided to organize such a Congress at an early date. To get matters moving, the Executive Council, in its meeting held on the 11th May, 1957, formed a "Provisional Local Steering Committee" at Calcutta consisting of the following members:—The President (Dr. M. L. Roonwal), Dr. B. S. Bhimachar, Dr. J. L. Bhaduri, Dr. H. N. Ray and Dr. B. S. Chauhan (Secretary). The Steering Committee has already held a number of meetings in this connnection and come to certain tentative decisions regarding the composition of the various sections, membership-subscription, application to the Government of India for financial grants, and so on. It is hoped now to finalise the venue and dates of the Congress. The Steering Committee also appointed a "Provisional Local Publication Steering Committee" consisting of the President (Dr. M. L. Roonwal), Dr. J. L. Bhaduri, Dr. H. N. Ray and Dr. *B. S. Chauhan* (*Convener*).

Suggestions received from various members all over India have stressed that the date and venue of the Congress be so fixed as to keep in view the convenience of University teachers and students. It is expected that a suitable venue and date will be finalized shortly.

Symposia on Zoological Topics

In January, 1957, we had held, with the aid of a liberal financial grant of Rs. 4,000 from the Government of India, our first Symposium at Calcutta. Unfortunately, the Proceedings of this Symposium have not yet been published owing partly to the full papers not having been received from several authors. It has now been decided to publish the Proceedings at an early date, and the communications from authors who have not yet supplied the full paper, will be printed as abstracts only.

A second symposium could not be organised, but our Secretary is trying to arrange one in 1958, in which task I hope he will soon be successful.

The Society's Awards

As the members know, at the last Annual General Meeting held in Calcutta on the 14th January, 1957, the Society had announced the first award of the Bhalerao Memorial Medal to Professor H. R. Mehra (of Allahabad) *in absentia* for meritorious research work in Helminthology. The medal was not ready at the time of that announcement. In the following months, a permanent steel die was made in Calcutta and a gold medal struck at a cost of about Rs. 400 (for the medal only). The medal is now before you and I hope you like it. You will also find it illustrated in our *Year-Book for* 1956-57, pp. 2. It will shortly be sent to Professor Mehra.

Representatives of the Society on outside Bodies

Indian Board for Wild-Life. The Society has re-elected Dr. H. Srinivasa Rao to continue to represent the Society on the Indian Board for Wild Life. Dr. Rao reports that response from the Members of the Society to the Wild Life Circulars sent round by him was very poor, just one member sending a reply. I would appeal to all of you to extend your fuller co-operation to Dr. Rao, and thus, through him, contribute to the preservation, well-being and enjoyment of our Wild Life.

I may add here that in my capacity as the Director, Zoological Survey of India, I am also the Honorary Secretary-General of the Board, and it is for this reason that I had suggested a departure from our past practice (when the Society's President represented the Society on

the Board) and elect someone else. I am glad that your choice has fallen on Dr. Rao.

The late Professor K. N. Bhal Memorial Fund

The sponsors of the appeal for the fund in memory of the late Prof. K.N. Bahl have placed at the disposal of the Society a sum of Rs. 574.34 nP. for administration, and our Treasurer has opened a separate fund on that account. The subscriptions to the fund have not yet been closed and a fresh appeal has been issued recently (*vide our Year Book for* 1956-57, p. 48). It is hoped that members will contribute liberally towards the fund.

Signatures and photographs, etc., of Members

The following decisions were taken by the Executive Council this year, and I hope the Secretary will be able to register appreciable progress in regard to all of these items:—

(i) *Register of signatures.*—Institution of a Bound Register to contain the autographs (signatures) of all members of the Society. Being of a permanent nature, the Register should be of high class ledger paper or, better still, rag paper so that the pages will not become brittle with the march of years. For a like reason, the ink used for the signatures should be black, indelible and water-proof.

(ii) *Album of photographs.*—Institution of an album to contain one or two photographs of every member of the Society. I hope all members will co-operate by sending photographs to the Society.

(iii) *Group photograph of members.*—Institution of a group-photograph of members who assemble at the Annual General Meetings. I hope we will make a beginning this year.

(iv) *Scroll to Members and Fellows.*—Presentation of formal scrolls to Members and Fellows on their admission to the Society. The format of these scrolls has been finalised and we expect that printed copies will soon be available for use by the Society.

The Society's Library

The Society's Library which is maintained at Calcutta received during the year 1957 about 200 additions which include periodicals, reprints and books, the more noteworthy among them being some Russian publications. The total number of volumes now in the Society's Library stands at 1416.

PART 2

UTILIZATION OF ZOOLOGICAL TALENT IN INDIA.

(a) *Preliminary remarks*:

I wish to lay before you a few thoughts on the utilization of zoological talent in the country so that the limited talent available may be used to the best advantage, and I would request you kindly to give your earnest consideration to them. As I have stated in Part 1 of this Address, the Society has already taken some steps in this direction, and it is hoped that the preparation of a *Who's Who of Members* and of a *National Register of Zoologists in India* will help to a certain extent in this task.

The utilization of zoological talent has to-day to be looked at in two aspects. First, the employment and utilization of the young zoologists who pass out every year from our Universities and Colleges. And secondly, the suitable employment of retired Zoologists who have behind them a solid experience of twenty-five or thirty years of research or teaching and who still have plenty of energy left to work, provided that a suitable place for research and some monetary help are given to them. I have purposely omitted the consideration of the middle-aged people who are well-established and who have still many years to go before retirement, as they do not face us with an urgent or serious problem at present.

For the problems of both the young and the old scientists, the solution is, to my mind, identical. It consists in providing suitable places for research where the workers may carry on their work in peace and have at least a certain degree of financial security guaranteed to them. Inspite of the ill-informed opinions expressed by some of our intelligentia that scientists should not care for financial rewards and must dedicate themselves to work in poverty, the fact is that the scientist is not to be compared to a frontline soldier living in a trench and ready to sacrifice his life to a bomb or a missile. We do greatly admire the soldier's courage and devotion. But good scientists, though usually born as such, have to be nurtured carefully. Unless they are provided with a suitable environment with a reasonable amount of freedom from the problems of bread-winning, much result may not be expected from their labours. To-day, the scientists are the lowest-paid and the highest-educated persons in India, a fundamentally wrong position for our science to-day. What applies to science in general, applies also to zoology.

The solution has two main aspects, *viz.*, the general and the specific, and I will deal with them separately.

(b) *The general aspects*:

Here again, we have two problems which need solution.

Cadres of scientific services.—As you know, there is at present no all-India cadre of the scientific services, and consequently the scientists suffer greatly in the matter of emoluments and promotions. Scientists are often obliged to leave one department for another in search of better prospects, and in this process of perambulation it frequently happens that their specialized knowledge is improperly utilized or wasted. If suitable cadres are formed, promising men will be attracted to them and will stick to the service.

Laboratories.—The second problem is the provision of suitable laboratories. In this field, the zoologists (and probably also the botanists) have the worst of it. By the term scientific research people to-day, not merely in India but also elsewhere, generally mean physico-chemical, atomic and nuclear research, and vast sums are spent in that direction, no doubt fruitfully. Biological research suffers like the proverbial Cinderella, but it will one day, let us hope, have its Prince Charming. It is gratifying that in a recent series of talks on the All-India Radio, Professor J. B. S. Haldane, the eminent British biologist, has pleaded in favour of laying a greater emphasis on biological researches such as evolution, animal behaviour, and so on. Biological research is perhaps more "civilizing" in its influence than other aspects of scientific research, and in this respect it is close to the humanities.

In India we have a large number of physical and chemical institutes, but similar institutes for biologcal subjects such as genetics, ecology, animal behaviour, etc., are still to come. Without the creation of such biological institutes, zoological research cannot be expected to flourish.

(c) *The specific aspects*:

Here too we may conveniently consider the solutions in two directions, *viz.*, those pertaining to the young zoologists and those to the retired ones.

(i) *The problems of the young zoologists.*—Because of the paucity of laboratories, the young zoologists are faced with the prospect of lack of employment. At the same time, some specialized departments do not find it too easy to recruit suitable personnel. This apparent contradiction is easily resolved, because the standards of teaching have, as generally admitted on all sides, gone down and the young zoologists who come to us often lack the requisite knowledge and background.

One solution of the problem is that which such bodies as the Indian Council of Agricultural Research practice, *viz.*, the creation of a large number of temporary research schemes which may run from one to ten years or more. But many basic problems still remain unsolved. The young zoologists after several years of temporary service in the schemes of research find themselves "left out", so to speak, for permanent jobs. Alternatively, they are constantly and legitimately, looking out for permanent jobs and are thus not able to devote their whole-hearted attention to the work of the Schemes. Furthermore, when a Scheme terminates at the end of, say, five years, the research personnel may have to accept an entirely different kind of work just to get settled in life, and the specialized training they received in the Scheme frequently goes to waste. One obvious solution for this difficulty is the creation, under the various bodies, of a permanent cadre of zoologists who could be transferred from one Scheme to another as the need arises without loss of security and of prospects of promotion.

(ii) *The problems of the retired zoologists.*—We have several retired zoologists in India who are still physically fit and capable of doing excellent work. It is a pity to let this magnificent pool of talent go to waste. The Government, as you know, is aware of the problem and has laid down policies to encourage the employment of suitable retired scientists.

Much still remains to be done at the non-Governmental level, and it is in this context that I would request the members of the Society to give their thought to the problem. For instance, I know at least two retired professors, still vigorous in health and willing to work, who have been trying in vain to get laboratory space for working at their own old Universities which they served for a life-time. The elimination of this kind of curious antipathy needs careful thought. If the Members of the Society can do something to help in finding solutions for such problems, they would be rendering a great service to science in India.

I now close this Address and thank you very much for the patient hearing given to it.

The 'Field' Concept of Organic Evolution

BY THOMAS A. MORRILL,

(Communicated by Dr. M. S. MANI),

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"Clearly biology at the middle of the twentieth century is in much the same position as was geology a hundred years ago in failing to observe that there is a Uniformitarian Principle pervading all types of organization whether in the inorganic realm or in the organic." Baitsell, *The Cell as a Structural Unit.*

Since establishment of evolution as a scientific fact with publication of Darwin's *Origin of Species* enormous advances have been made in biology. At the same time, the mechanisms subsumed under natural selection theory, i.e., accidental hereditary changes and environmental selection, have increasingly been established as central mechanisms of evolution. Yet, since 1859 individual scientists have steadily lost touch with the whole of biology. Becoming extremely specialized, they are unfamiliar with advances in other than narrow fields, and doubt the general validity of their own discoveries. Though organic evolution is the supreme scientific object, especially warranting open-mindedness and broad and continuing speculation, peculiarly there is about it the most apathy and rigidity. No attempt to define basic evolutionary principles from a general survey of biology seems to have been made since Darwin's attempt in 1859.

When the whole of biology is viewed with an open mind, not from the point of what is traditional, but from what is logical and supported by evidence, a very different concept emerges from Darwinism. Anomalies become the rule in a system far more inclusive than that which for nearly a century has been the paramount evolutionary theory.

Proteins, Genes and Cells

The findings of biochemistry and cytology in the century since the *'Origin'* have brought down to terms of chemistry and cell fine-structure what men have known since the dawn of consciousness: that organisms possess tremendous responsiveness and interrelation of parts. F. Sanger considers that the specificity of a protein molecule is determined "by the synthetic mechanisms whereby it is produced and by the nature of the biological roles that it has to perform." Haurowitz regards proteins as families of highly individualized molecules, individual differences arising from "the history of the molecule, its age, its of formation, and its exposure to various extrinsic factors." (14) (p. 14) Thus "..... in protein chemistry, a switch must be made from the classical chemical to a truly biological-chemical point of view....." (p. 12) Similiarly, a switch is in order from the classical view of genes.

The classical gene was formulated largely by Hugo De Vries in 1900 in the book *Die Mutationtheorie.* The Dutch botanist was a follower of August Weismann who in 1891 announced the complete separation of germplasm and somatoplasm. The experimental evidence being the normal-appearing tails of mice after five generations of tail amputations. The gene was conceived as a particle capable of random, i.e., equally beneficial and injurious, changes having no relation to the rest of the organism:

As the theory of mutations I designate the statement that the properties of organisms are built from sharply distinct units ..... Intergrades, which are so numerous between external forms of plants and animals, exist between these units no more than between molecules of chemistry.

Such units bear little resembiance to "molecules of chemistry" as they are known to-day; certainly not to organic molecules in living organisms. Yet the neo-Darwinian view of evolution is predicated on the De Vries gene.

As Sewall Wright (*Encyclopaedia Britannica*, 1956 ed., "Evolution") puts it, the gene changes only on "absorption of thermal, chemical, or radiant energy ..... unrelated to the characteristics of the organism as a whole." The gene, in the words of H. J. Muller (*Britannica* "Variation") changes only when "something goes wrong," by "an accident of submicroscopic dimension, dependent on the occurrence of certain 'chance' configurations of atoms, electrons and energy-quanta within or near to the gene in question." So firm is belief in the De Vries gene that geneticists apply the value terms "good" and "bad" to genes according to whether they conform to De Vriesian criteria. As C. C. Lindegren, 1953, wrote: "A 'good' is easy to diagnose....., is relatively unaffected by environment, does not diminish vigor to an unusual extent, and unusally gives regular ratios." Lindegren, 1956, observed that "much of the early work in genetics was devoted to selection of stocks carrying 'good' genes."

It is now established that nucleic acids of the type known as DNA form the cores of genes. DNA in living cells is always intimately associated with proteins as nucleoproteins. Viruses are observed under the electron microscope to consist of crores which test as nucleic acid surrounded by protein cylinders. DNA fractions with protein extracted produce the well known "transformations" of traits between related strains of bacteria—a phenomenon duplicated in ducks by Benoit in 1957. Only the viral core enters cells, there to reproduce the complete infective virus. Mirsky, 1953, described DNA as a "large complicated structure: It may contain as many as 3000 molecules of 5 carbon sugar." Two other authorities observe that DNA consists of polynu-

cleotide chains which "may contain thousands of nucleotides, [thus] ..... an almost infinite number of specific seids is possible." (49).

One of the most significant facts about nucleoproteins is that they are not, "nucleoprotein" being a misnomer, peculiar to the nucleus. Cytoplasm in most tissues contains more nucleoprotein than do nuclei: in testis, one-and-one-half times as much; in liver where the ratio is highest, four times as much. (28) DNA's partner in the cytoplasm, RNA, closely resembles DNA in chemical structure. RNA, not DNA, is the nucleic acid in a number of viruses. Small amounts of RNA occur in chromosomes, according to Dounce, integral with DNA. Hotchkiss, 1955, cites evidence that in its isolated state apart from organisms, DNA is "much more" labile than protein or RNA. Cytoplasmic RNA's greater lability and turnover is evidently because of over-all regulation in the organism, not because of intrinsic difference. DNA-protein seems to be distinguished by a buffered and equipoised situation in the organism and consequently more extensive interlinkage rather than by peculiarly refractory intrinsic properties. RNA-protein appears to develop DNA-protein specificity in the cytoplasm where it directs protein synthesis and energy release. The process has been likened to expansion of information from a monemonic key. But RNA-answers do not come simply from the genes any more than test-answers come directly from a key; the answers and the key come from the organism reacting with the world.

Radio-tracer tests show that RNA-protein passes through nuclear membranes. (18) Electron photomicrographs indicate RNA synthesis at the cytoplasmicnuclear interface as well as "bunches of granules" in nuclear membrane pores as though fixed in passage. (44) Labelled protein is detected in nuclei ten minutes after injection into tails of mice. (8) From electron microscope studies, Palade, 1956, concludes that animal cell membranes incorporate material "in bulk" somewhat as protozoa ingest in vacuoles because membranes are not smooth but consist of ruffles, pockets and vesicles. Most cytoplasmic RNA-protein occurs in membraneous structures, the mitochondria and endoplasmic reticulum. This evidently is the means of organizing energy release and protein synthesis, providing flow as on an assembly line. Palade believes that the endoplasmic reticulum extends from nuclear to cell membranes, patterning chemical events and controlling import, export, and circulation in the cell.

Mutatian—Beneficial?

For genes to change constructively and solely from intrinsic accidents, certain conditions are absolute prerequisites: First, genes must consist of materials completely unlike others in living organisms, i.e., they must have a completely capricious, kaliedoscopic architecture, allowing for random and not orderly and step-wise changes from the chemistry and kinetics or organisms. Secondly, cell and nuclear membranes

must rigorously isolate these peculiar materials from the manifold and efficient organizing and regulating processes in the organism. We have seen that the findings of biochemists and cytologists make clear that such conditions do not exist.

De Vries assumed a one-to-one relationship between gene and character. Instead each gene influences many characters; all characters are affected by many genes. Thus in *Principles of Embryology* (1956), C. H. Waddington states: "genes affect the pattern as a whole and not only the individual units comprising it." In *Drosophila* twenty-five genes are known to affect eye color. ".....all or nearly all genes are active in every tissue." Madison finds that a gene—rather, its absence —causing short ear in mice also affects creatine excretion in the urine. A single gene change which improved one character with reference to an environment, bringing about a needed adjustment, would be generally disorganizing because toward other characters it was not compensated for and correlated with changes in other genes. *The integrity of organisms involves mutual adjustment among parts*; the mutation theory assumes that changes in single parts alone, and the most highly integral parts, can be beneficial.

But *genes do not occur as single parts.* "Position effect" proves that genes are not corpuscular. According to Marshak, 1955, the whole chromosome and possibly the whole chromosome complex is composed of "functionally inter-related elements." The opposite of De Vries' hypothetical "sharply distinct units," the highly molecularized gene continuum is precisely the system for receiving and assimilating changes in organisms as wholes. Furthermore, this subtle and extensive system is the least likely to evolve by accidents.

That genes are integral components of living organisms is also attested to by the non-randomness of single-gene changes: *Isolated and accidental gene changes are not random.* "Well over 99 per cent are harmful," writes H. J. Muller. (47) (De Vries' *Oenothera* "mutation" turned out to be primarily position effect, exactly the opposite of changes in single genes uninfluenced by other genes.) Mutations also are not random because they are repeated, and many genes are not observed to mutate at all. (11).

Without concrete and abundant evidence to the contrary, it is to be expected that encounters between highly organized biological systems and agents toward which there is no organized response cannot be other than destructive. Injury is the criterion of mutation in the laboratory. For example, see Beadel and Tatum's "Neurospora II" "Tests for Mutations," or Regehr *et al* on betatron-produced mutations: "It is common practice to judge mutagenic efficiency of radiation by the frequency with which recessive sex-linked lethals are induced in the fly *Drosophila melanogaster.*" In his 1931 paper, Wright declared: "actually observed gene mutations seem about as unfavorable as could be imagined for

adaptive evolution." Noting that "it has yet to be shown that any mutant has an advantage in the wild," Kenneth Mather continues:

> as we see it in the laboratory, mutation appears to be more a process of gene degradation, retrogressive in that it wipes out or reduces the capacity of the individual to display some character or to discharge some function, rather than progressive in endowing it with normal ability. ..... Even where such constructive changes have been recorded ....., they arise by recombinations rather than by mutation in the strict sense.

Genes *can* change by accidents as organisms can change by accidents. But it is not enough to show that genes can change by accidents to account for evolutionary changes in this way. It must also be shown that such changes benefit the organism. This emphatically has not been done. On the other hand, is accident the *only* mode of gene change? Following the next section, a number and variety of experimentally controlled gene changes from physiological processes will be reviewed. However, even if gene accidents were beneficial and the only mode of gene change, would they be selectable?

Mutations—Selectable?

Belief that single gene changes will be decisive in organism survival is largely based on the striking effects of incapacitation of certain genes. Any of the following facts alone seems to discount this evidence: 1. Only a few genes are lost with the massive effects noted in support of gene selection. 2. Mutations produce striking changes from complete inactivation; but genes will not have arisen in single steps. 3. Removal of a gene in an evolved organism will have far greater effects than will steps in the gene's development before it becomes focal and basic. Placing a keystone in a building under construction has a very small effect compared with that of the stone's removal after the structure is completed. It is now generally believed, as Muller writes (*Britannica* "Variation"), that "most mutations never show," that evolution is by "numerous selected small steps....." The question is whether small-step changes in gene loci, unrelated to other genes, even if constructive, are selectable over series of generations.

A commonly stated number of genes linked in a chromosome is 2000. In the human then, there are 48,000 gene pairs, 96,000 genes. Most mammals contain at least 50,000 genes. Clearly such enormous numbers of genes cannot have evolved by selection of small step changes in single genes unless total gene systems are extremely constant over series of generations. And *thousands of genes enter and leave gene systems each generation in sexual reproduction.* Furthermore, a given gene's expression is not the same from combination to combination. The gene causing short ear in mice decreases creatine excretion in males, *increases* it in females. Wright declares that genes' pleitropic effects are "rarely if ever wholly predictable ....." (71). He observes (70) that "Selection ..... applies to the organism as a whole ..... rather

than to single genes," and that a given gene, favorable in one chromosome combination, will be unfavourable in another. And if gene action is altered by change in chromosome complement, it is even more changed by change in gene complement within the chromosome—position effect.

Conclusion: Local gene accidents will ordinarily not be selectable in sexually reproducing organisms because swamped by changes in gene combinations each generation. Selection operates primarily on 1. chromsome recombinations—Darwin's "indefinite variations"; or on 2. changes in gene complexes. The second assumes correlated induction of multiple gene changes. The next four sections present evidence, that, Weismannism notwithstanding, genes are physiological structures changing through physiological processes in organisms.

Re-"gene"-eration

That genes are altered by X-ray and other agents powerfully antagonistic to living organisms has been hailed as a major advance in biology. The really significant fact attendant upon Muller's discovery, and wholesale production of mutations, has been largely ignored: it is that mutations "backmutate." Rather, life processes repair genetic damage, for considering the phenomenon merely another mutation is like believing that a man run over by an automobile is made well when the car returns and runs over him again. *Instead of showing incoordinance of genes in the organism, wholesale mutations have been the means of demonstrating conclusively that genes are parts of organisms, changing as parts of organisms.*

In the presence of certain a-hydroxy acids, reports B. Wright, *E. coli* bacteria which have lost the ability to synthesize glycine "periodically transform themselvse into cell types capable of synthesizing serine and glycine at stepwise increasing rates. ....." The gene—repair, called by Wright "auto-adaptation," arises on addition of a normally-occuring organic substance to the culture medium; beyond this, the organisms produce, and *are,* their own substrates; changes are population-wide and cumulative over a predictable time. "Predictable mutation" is also described by M. I. Bunting in non-pigmented mutants of the red bacteria, *Serratia marcenscens*: Reversion to red was "greatly accelerated by the presence of yeast extract or peptone, and in such supplemented media reversion was apparently a mass phenomenon." Gene repair is not confined to microorganisms. Timofeeff-Ressovsky who studied it in *Drosophila* found it occuring at a much higher rate than the injury at the same locus.

Recovery from ultraviolet injury in the presence of visible light, a very widely observed phenomenon, is another instance of organisms responding to a normally-occuring external agent with gene development. Recovery is largely in the nucleus and comes from interaction of visible

light with cytoplasm. (6) The "healing light" is of wave lengths just over the line from the long-wave ultraviolet which causes the recoverable damage. Injury from short-wave ultraviolet is not photorecoverable (24) nor is that from X-ray.

It is significant that the neo-Darwinians, hard-pressed for examples of beneficial mutations, regard the tremendously interesting and experimentally accessible phenomenon of gene repair as an embarassing annoyance. As Lindegren writes: " 'good' genes are produced by irreparable injury to the gene." (29).

Nuclear Differentiation

In *Paramecium caudatum* the macronucleus consists of forty nucleus proliferations. These "genomes" are fixed with relation to cytoplasmic organelles. (They correspond to somatic nuclei in metazoa.) Sonneborn reports: differentiation of nuclei "seems to be a prime factor in *Paramecium*." (53) In 1951 this same authority wrote that nuclear changes arise from local differences in cytoplasm, which in at least one case was itself under nuclear control. Following up some of Sonneborn's discoveries, David Nanney, 1953, learned that position in the cytoplasm not only determines the type of macronucleus a micronucleus becomes, it determines whether a micronucleus becomes a macronucleus. In a certain region, a micronucleus remains a micronucleus; in other regions, it becomes a macronucleus.

Some of the most interesting work on cytoplasmic modification of protozoa nuclei has been done by P. B. Weisz. Isolating cell fragments containing genomes at various locations and stages between divisions, he compared their subsequent development. Soon after fission, genomes began a gradual change, those near organelles continuing to regenerate complete animals, those more distant failing in some aspect of morphogenisis. Weisz, 1954, explains the mechanisms as follows:

> the nuclear apparatus emits specific enzymatic agents into the endoplasm. Variously differentiated kinetosomes utilize these agents selectively .....; and they produce specific enzymatic agents which act back on the nuclear apparatus, controlling its kinesis and its metabolic activity.

It is reasonable that the extensive and efficient differentiation of metazoa requires gene changes in order to direct changes in cells. Even if this were not so, given the vast alterations in cytoplasm a few millimicra away, somatic genes could not be expected to be unaltered. Heretofore the view, dictated by neo-Darwinism, that changes were "cytoplasmic only" could be maintained because there was no way to test isolated somatic nuclei as Weisz tested protozoa genomes. This is no longer the case. In now famous experiments first reported in 1954, T. J. King and Robert Briggs implant nuclei of frog somatic cells into enucleated frog eggs. Injury to nuclei and eggs is not sufficient to prevent normal development in eggs receiving nuclei from non-differentiated embryo regions. If nuclei from differentiated regions are

unaltered, it is expected that they would initiate and carry on growth of normal embryos. Using an improved technique over that available in 1954, King and Briggs in 1955 got normal cleavage of 22 rather than 8 per cent of "chorda-mesoderm eggs." "On this basis," they write, "one would expect a definite improvement in the later development of the blastulae." No blastulae grew normally. Nuclei were shown to be specifically modified: In "chordamesoderm blastulae ..... notochord and somites were differentiated," while "the central nervous system was deficient and occasionally absent." "Endoderm blastulae" from eggs implanted with presumptive gut nuclei have the gut well developed while "all ectodermal derivatives ..... are poorly developed and display degenerative changes." In 1956 King and Briggs "established the heritability of nuclear alterations through serial transfer of differentiated nuclei." (42).

The role of cytoplasm in determining such nuclear alterations is well known. For example, the grey crescent region of the amphibian egg cytoplasm is essential for mesoderm growth; factors in other egg regions enable cells to become ectoderm and endoderm. "..... for embryology," states Waddington, "cytoplasm is as fundamental as the genes."

Nanney, 1956, points to differentiation of heritable mating types from the same parent genes in protozoa as an example of the important phenomenon which the King-Briggs work illustrates. He observes that nuclear differentiation involves not single traits but "constellations of characteristics," and also differs from mutation in that it is not "distributed randomly in time" but arises by specific response to specific intra-cellular stimuli. In their introduction, 1955, King and Briggs write that formerly somatic differentiation could not be attributed to nuclear change, for the only kind of nuclear change known, mutation, occurs "infrequently and unpredictably, while what was required was a coordinated series of directed gene changes." The "coordinated series of directed gene changes" has now been demonstrated. Though not applying his reasoning expressly to evolution where it seems even more pertinent than for cell physiology, A. E. Mirsky anticipated the King-Briggs results, writing in 1953: "There is need for a feedback from the cytoplasm to chromsomes so that the latters' activity is adjusted to the cytoplasm's special requirements." Relating his genome experiments to embryology, Weisz in another 1953 article concludes: *"The nucleus, sometimes looked at as the absolute ruler of the cell, now appears to be under the control of the very components it controls!"*

Conclusion: *The characteristics of organisms are not "built from" genes as De Vries imagined, but from chain and cyclic reactions in which genes change through interactions with products they help form. "Evolution" is a form of growth.* —(*to continue*).

Taxonomic status of the blood pheasants of Nepal and Sikkim

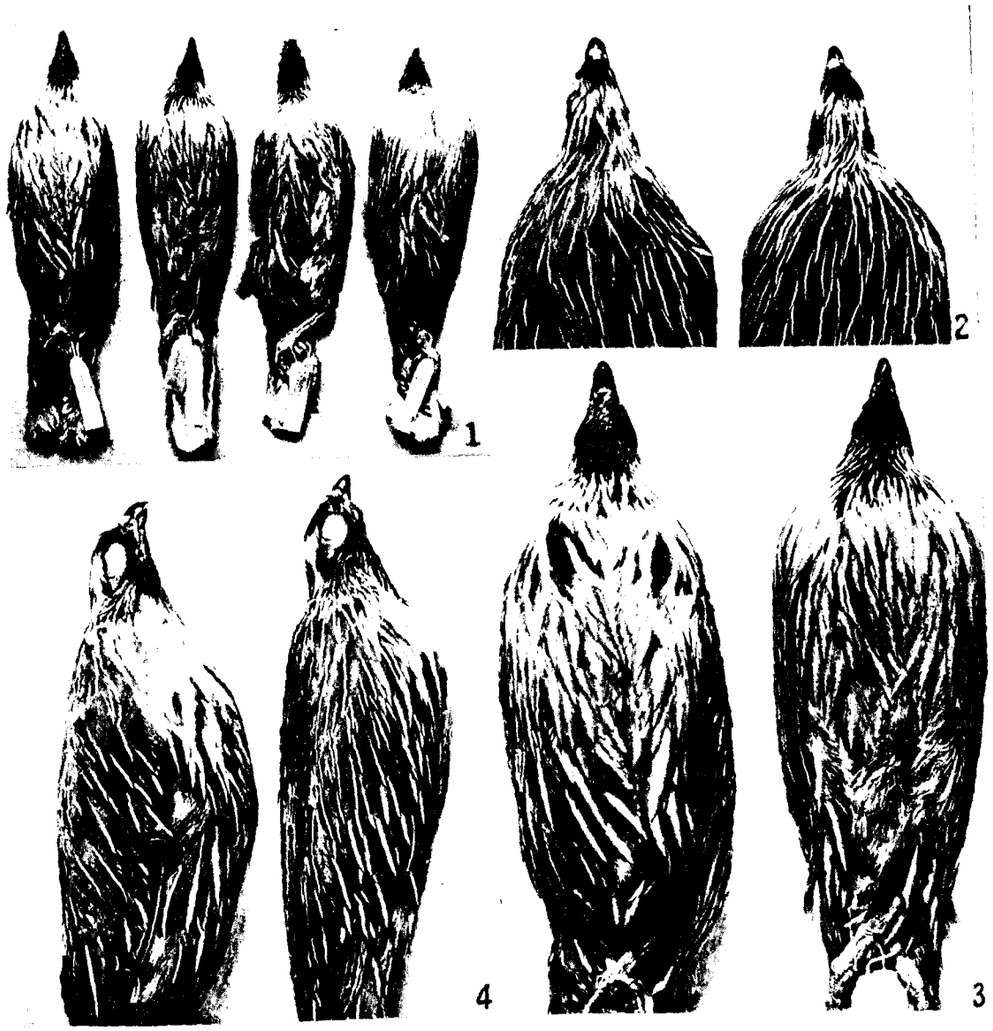
BY BISWAMOY BISWAS
Zoological Survey of India, Indian Museum, Calcutta

(With one Plate)

The blood pheasant of Sikkim was separated from that of Nepal by Beebe (1912) as *Ithaginis cruentus affinis* on the basis of its male having decidedly reduced crimson on the underside and the two outer pairs of rectrices completely lacking crimson. The colour differences were, however, already noticed by Ogilvie-Grant (1893, p. 268, note) among other earlier authors. Baker (1915) while reviewing the genus '*Ithagenes*', came across some specimens bearing Darjeeling as locality on their labels, which he considered identical with the Nepali bird. He, therefore, synonymized Beebe's *affinis* with the nominate *cruentus* of Nepal, thereby extending the range of the latter farther eastward to western Bhutan. This arrangement has since been followed by all subsequent workers (Baker, 1928, pp. 352-354; Peters, 1934, p. 107; Ludlow and Kinnear, 1937, p. 499; Delacour, 1951, pp. 50-51).

Recent collections of blood pheasants made by me in northern Sikkim (Lachung Valley, alt. *ca.* 3200 meters) and in northeastern Nepal (Khumbu, Dudh Kosi and Imje Valleys, alt. *ca.* 3650-4300 meters) show that the Sikkim bird differs quite from Nepal's, the differences as shown by my six specimens from Sikkim being constant (Pl 1, fig. 1). Mr. Jean Delacour, to whom these collections were sent, made a very careful comparison with the fine material of the American Museum of Natural History. He now agrees that the Nepal and Sikkim birds are indeed different. Compared with the Nepal bird, the Sikkim male has the forecrown without crimson, the throat with a little crimson but black showing through it, much reduced crimson on the breast, and a little more green on the flank and the Sikkim female is less grey. The absence of crimson on the outer tail feathers of the Sikkim male as mentioned by Beebe, is, however, not borne out by my material. Furthermore, no appreciable difference in size between the two populations is discernible.

It follows, therefore, that *Ithaginis cruentus affinis* Beebe is a distinct and valid subspecies *contra* Baker (1915). His judgement on the similar identity of the Nepal and Sikkim blood pheasants was in



BLOOD PHEASANTS OF NEPAL AND SIKKIM

Fig. 1.—A group of male birds (ventral view). The specimen on the extreme left is from Nepal (*Ithaginis c. cruentus*); others are from Sikkim (*I. c. affinis*).

Fig. 2.—4. Close-up of male birds (dorsal, ventral and lateral views). A Nepali specimen is shown on the left of each photograph, and a Sikkimi bird, on the right.

[Photographs by the author]

all probability influenced by the specimens bearing the 'Darjeeling' labels. Beebe had also hinted at the doubtfulness of this locality data.

I am thankful to Mr. Jean Delacour, Director of the Los Angeles Country Museum, Califorina, for comparing my material with that at New York, and to Professor J. L. Bhaduri of the Zoology Department, Calcutta University, and my colleague Dr. K. K. Tiwari, for help in the preparation of this note.

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Review

Dr. Sir Harisingh Gour Commemoration Volume. (*December 25, 1957 : Eighth Death-Anniversary*. pp. 35+(2)+382+136+88, one frontispiece, 35 pls.—Saugar University, Sagar (M.P.). 25th December 1957. Price Rs. 20/-.

This sumptuous volume has been issued by the Saugar University, Sagar (Madhya Pradesh), in commemoration of the late Dr. Sir Harising Gour (1870—1949) through whose princely benefaction the Saugar University was founded and who was its first Vice-Chancellor. Dr. Gour was in his days the leading Jurist and practicising lawyer of India, but his versatile genius illuminated and benefited many other fields such as politics, literature and, above all, education. He was successively the Vice-Chancellor of Delhi, Nagpur and Saugar Universities.

The volume contains, besides appreciative messages and the fascinating autobiography of Dr. Gour, a number of special contributions among which we are concerned here mainly with those dealing with biology and especially zoology. Four such articles are present.

Dr. P. PARIJA, in an article on the "*Nature of Life*" (pp. 237-240), deals briefly with the more important characteristics of life, its origin and the distinction between plants and animals.

Dr. M. L. ROONWAL, in an article on "*Modern Trends in Zoological Research and Thought*" (pp. 280-283), recognizes twelve majore disciplines of zoology, *viz.*, Systematics (or Taxonomy); Morphology and Anatomy; Enbryology; Cytology and Histology; Genetics; Comparative Physiology (or Experimental Zoology); General Biology (including bionomics, life-h'stories, etc.); Evolutionary Biology; Zoogeography; Palaeontology; Economic Zoology; and History of Biology. He deals briefly with each of them, emphasizing the recent trends in their development, with particular reference to India. He points out that in most of these disciplines progress in India is far from satisfactory, and some of them, *e.g.*, genetics, have hardly even been started. Emphasis is laid on the development of work on systematics and genetics, in addition to a number of other branches. Dr. Roonwal also suggests that the Universities should, in his opinion, devote their energies to fundamental rather than applied work.

Drs. B. S. CHAUHAN and Y. S. CHAUHAN, in an article on "*Human Schistosomiasis in India*" (pp. 296-306), give an account of the causation and transmission of this tropical disease, with particular reference to its foci in India. Schistosomiasis in man and animals is caused by blood-flukes belonging to the Trematode genus *Schistosoma* the intermediate hosts of which are certain molluscs. While endemic animal schistosomiasis has been known in India since long, the

existence of endemicity of the disease in human beings in India was established only during the last ten years, the endemeic areas being the Ratnagiri District of the Bombay State.

Dr. S. M. QADRI 'ZORE', in an article on "*Scientific Literature in Urdu and its Promoters*" (pp. 326-329), traces the history of the subject and states that the development of scientific literature in Urdu took place largely in Hyderabad (Andhra Pradesh). At first this development took the shape of translation of scientific works in the European languages into Urdu. According to the author, the first such translations were made in 1818 under the patronage of the Moslem rulers of Hyderabad. The author further states: "In this period only a book was written on Zoology dealing with different types of animals and their characteristics. It was also translated into Urdu and published in 1848." Unfortunately, the name of the auther and the title of the book are not mentioned. Subsequent developments took place with the founding the Osmania University in Hyderabad in 1917 when a "translation bureau" was established, and books on zoology, fisheries, etc, were translated into Urdu, but here again the names of the books are not mentioned. The author concludes that these translations resulted in the coining of "vast treasures of technical terms" which "can be, with necessary modifications, utilised in developing Hindi and enriching it to become the language of the Indian nation".

M. L. ROONWAL

ANNOUNCEMENT

Zoological Society of India

PRIME MINISTER ACCEPTS HONORARY PATRONSHIP

The Prime Minister of India, Shri Jawaharlal Nehru has graciously agreed to be the Honorary Patron of the Zoological Society of India.

Review

Acharya Jagadish Chandra Bose Birth Centenary Volume (Vol. 22, 1958, of *Transactions of the Bose Research Institute*, Calcutta, pp. xl+230, one frontispiece, 15 plates.—Published by Bose Res. Inst., Calcutta. 30th November, 1958. Price not mentioned.

The birth centenary of the famous physicist and plant physiologist, Jagadish Chandra Bose (1858-1937) was fittingly observed at the Bose Research Institute, Calcutta, on the 30th November, 1958. Volume 22 (for 1958) of the *Transactions* of the Inst tute was converted into a special one for the occasion. Apart from a short life-sketch, a portrait of J. C. Bose and a brief account of the activities of the Institute since its founding in 1917, the volume contains twenty-one article by well known personalities in science on a variety of topics.

Their subject-wise distribution is roughly as follows, but there is some overlap so that a paper sometimes falls under more than one subject:—General biology 4; botany 8; zoology 2; physics 2; chemistry 7; and statistics 1. We are concerned here with some of the articles which deal with zoological and general biological matters of which there are seven.

M. L. ROONWAL, in his paper on "*Recent work on termite research in India (1947-57)*" (pp. 77-100, 4 pls), gives an account of developments in termites of the orient, and especially of the Indian Region, in the field of systematics, zoogeography, morphology, cytology, physiology, biology, ecology and control. Substantial advances have been made especially in systematics where a large monograph by Roonwal and Sen-Sarma on some of the oriental species is mentioned. The morphology of the common mound-building termite of India, *Odontotermes obesus* (Rambur), has been worked out in detail by K. S. Kushwaha. Work on the physiology of digestion of cellulose by termites has been done by J. N. Misra. Some interesting work on termite castes and on royal chambers is also reviewed. Finally, a summary of the work on termite control is given. At the end there is a full bibliography of about 140 references.

J. D. BERNAL's paper on "*Some reflections on structure and function in the evolution of life*" (pp. 101-110) is a semi-philosophical essay of the origin and evolution of life, especially in terms of the molecular structure of high polymers.

N. W. PIRIE in his paper on "*The position of stereoisomerism in argument about the origins of life*" (pp. 111-120) deals with the concept of "chirality" or right and left handedness of chemical molecules in relation to the origin of life. The discussion is rather complex except perhaps for readers with a background of advanced chemistry.

A. I. OPARIN, the Russian biologist, in his paper on "*Coacervate drops as the initial systems on the way to the origin of life*" (pp. 121-125) reiterates his well known theory of the origin of life on earth through the formation of minute "coacervate drops" which have most of the properties of life. He gives further details of obtaining such drops artificially in the laboratory by suitable chemical reactions and incorporating them with nucleic acid and other chemicals which are essential constituents of a biological cell.

B. C. GUHA in his paper on "*The biosynthesis of ascorbic acid by animal tissue in vitro*" (pp. 143–153) has summarised the results of his work on various animals, *e.g.*, toads, birds, rats and bats, to show that the liver and kidney can synthesis ascorbic acid in the presence of cyanide *in vitro*. He has further shown that cyanide has a remarkable stimulating effect on the biosynthesis of L—ascorbic acid from D—glucuronolactone by animal tissues *in vitro*.

K. S. KORGAONKAR and V. R. KHANOLKAR have given an interesting paper on "*Role of spectrophotometry in biology and medicine*" (pp. 155-168).

J. B. S. HALDANE, in his paper on "*The statistical study of animal behaviour* (pp. 201-204), summarises the results of his experiments on the behaviour of the newt, *Triturus cristatus*, and the *koi* fish, *Anabas testudineus*, in their periodic ascent to the water-surface for breathing. He emphasises that such experiments while providing interesting information require very little apparatus and are specially suited to conditions in India where it is difficult to obtain costly and complicated apparatus.

M. L. Roonwal.

Correspondence

With reference to the paper on "Seasonal variations to the Glycogen and Fat content in the Apple Snail, *Pila Virens* (Lamarck) by Miss V. R. Meenakshi published in the *Journal of the Zoological Society of India* Vol VIII No. 1. Dr. J. C. George writes in the course of a letter as follows :—

On page 62 she writes, "The present study has shown that glycogen is the main source of energy during aestivation and reproductive activity. This conclusion is in line with what is known for other molluscs, but does not agree with the findings of George and Desai (1954) who infer that fat is the main source of energy during aestivation in *Pila globosa*. This discrepancy is most probably due to the fact that George and Desai (1954) have studied the fat content of the digestive gland alone, but not the total fat content of the animal, particularly in the foot which contains an appreciable amount of glycogen".

We in our paper have never claimed to have observed that fat is the chief fuel during aestivation and reproductive activity in *Pila*. All that we said was; (Page 58) "The main material in the liver of *Pila* is fat and not glycogen. There is a great deal of seasonal variation in the fat content of the liver in both the sexes. It is at its maximum in January and minimum during September. It is utilized for providing energy during aestivation and in the production of eggs and sperms. She has observed in her own studies that the digestive gland contains "only traces of glycogen" and that fat is also utilized during aestivation though only one fourth of that of glycogen :—

[The problem has been studied with different modes of approach by the authors and the findings do not appear to be conflicting and irreconcilable.] —Editor

ANNOUNCEMENT

Dr. M. N. Roonwal *(Director, Zoological Survey of India)*

(i) Has been appointed as a Member of the Indian Historical Records Commission of the Government of India.

(ii) Attended a meeting of the first session of the International Advisory Committee for Humid Tropics Research, held at Manaus (Brazil) from the 29th to 31st July, 1957.

Forthcoming Papers

The following papers will be published in the next issue of the Journal: Vol. X. No. 2.

BHOLA NATH	Animal remains of the 12th centuary A. D. from Saranath, Uttar Pradesh, India.
SWAMINATHAN, S.	Amino acid composition of the crystalline style of *Telescopium telescopium* (Linn.) (Gastropoda : Prosobranchia)
ALIKUNHI, K. H.	Notes on a collection of Stomatopod Larvae from the Bay of Bengal off Mahanadi Estuary.
NATARAJAN, R.	Chromosomes of some estuarine Pulmonate Gastropods. I.
BHANOTAR, R. K.	Asymmetry in the striped eyes of the Desert Locust *Schistocerca gregaria* (Forskal).
SRIRAMULU, V.	A quantitative study of the protein-bound amino acids during the development of *Oryzias melastigma* (McClelland).
KHASYAP, H. V.	The circulatory system of *Natrix natrix piscator* (Schneider).
JAIN, S. L.	New species of the genus *Urocleidus* Miieller from the gill filaments of some Indian Fishes.
VICTOR GLADSTONE, V and PANDYAN (Miss), A. S.	A case of malformation in the azygos vein and vena cava inferior in *Tatera indica* (Hardw)

Journal of the Zoological Society of India

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Other Publications: Year-Book of the Zoological Society of India (1956 57 and 1957–58) Rs. 2/- each, Indian Zoological Memoirs (initiated by the late Prof. K. N. Bahl) Nos. 6, 7 & 3 available.

All communications regarding the above should be addressed to:

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The Hony. Treasurer.

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Date, 31-3-'59.

R. V. SESHAIYA,
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