OBSERVATIONS ON THE RATE OF GROWTH AND LONGEVITY OF *TROCHUS NILOTICUS* LINN. IN THE ANDAMAN IS.

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(Plate XIV.)

There is a considerable volume of literature on the rate of growth of various species of the Lamellibranchiata, but comparatively little attention seems to have been paid to the problems of growth in the Gastropoda. Russell (1909) and later Orton (1914) studied the rate of growth and other allied problems in *Patella vulgata* Linn. along the coasts of Great Britain. Sewell (1924) gave an account of his observations on growth in certain marine, fresh- and brackish-water forms of Mollusca of the Nicobar Is., India, and the Gulf of Suez respectively. Crofts (1929) in her memoir on *Haliotis tuberculata* Linn. recorded a few observations on the rate of growth of this species. Abe (1932) studied the age and growth of the Limpet, *Acmaea dorsuosa* Gould in the Japanese waters. In this paper are cited references to the works of Nomura, Ohue, Takano and others which are published in the Japanese language in journals not available in India. Moorhouse (1932) studied the rate of growth in *Trochus niloticus* Linn. on the Queensland coast of Australia. His is, perhaps, one of the few contributions to our knowledge of growth in a large species of marine Gastropod. The results of his study were based on (1) measurement of marked and numbered individuals confined in cages left in the sea, (2) monthly measurement of 600 free-living animals and (3) measurement of specially marked free-living animals. The individuals used in his studies were generally small, and the maximum diameter of the shells ranged between 2 and 5 centimetres with a few exceptions which measured up to 8·3 cms. The duration of his observations was between 4 and 8 months. His conclusions are that growth in the shell is continuous, though irregular, except for a short period in winter, and that the approximate monthly rate of growth is 0·23 cm., and that shells between 2·5 and 3·0 cms., 5·0 and 6·0 cms., and 7·0 and 8·0 cms. in maximum diameter are 1, 2 and 3 years old respectively.

While stationed in Port Blair as Officer-in-charge of the Andaman *Trochus* shell-fishery investigations from May 1932 to July 1935, I had the opportunity to make observations on the growth of the shell in *Trochus niloticus* in the vicinity of Port Blair, which are presented in this paper.

The first experiment on growth-rate in *T niloticus* with the maximum diameter of the shell as the criterion was started in April 1932 by Dr. C. Amirthalingam (then stationed in Port Blair as Research Officer of the Andaman Fisheries) with a hundred examples of various sizes. Thick copper tags with serial numbers deeply engraved on them were secured to the outer lip of the shells by means of stout copper wire passing through holes bored in them. The measurements of the shells, namely, the maximum and minimum diameters and the height, were noted, and the shells were left under stones and coral reefs at low tide near the South Point Navigation Light, Port Blair. A search for the numbered individuals was made every month whenever the tides were favourable, and the measurements recorded. At the end of the first month, I continued the observations started by Dr. Amirthalingam, and found only 55 shells out of the hundred with which the experiment was started. At the end of the second month 20 living and 6 dead specimens were found. In September 1932, out of 34 numbered specimens recovered from the reefs, only 8 were living, and in December 1932 only 3 living specimens were found. The outer lip and spire of the shells were found damaged in many of the shells, and the copper tags and wire were very much worn. The stormy weather that prevailed in Port Blair during part of the monsoon resulting in the dislocation of the coral masses under which the shells were kept may have been partly responsible for the damage to the shell of the experimental specimens. Fresh regions of growth, along the margins of the mouth of the shell seen in several specimens, particularly where the shell had been bored for the passage of the copper wire, indicated that normal growth had in some way been retarded. But one of the causes of mortality among the animals may have, at any rate, been attack by their natural enemies.

In January 1933 the experiment was restarted with 200 examples below 7 cms. in diameter[1] collected along the eastern coast of Havelock I. of the Ritchie's Archipelago. The venue of the experiment was changed from S. Point to a long strip of coral shingle (pl. XIV, fig. 1) on the north-west of Ross I., Port Blair, uncovered by the sea at ordinary low tides, and somewhat protected from the monsoons. The shells were all numbered as before, and left in groups of 4 or 5 under marked boulders of coral rock. Ten days later, the area was searched for the numbered shells, but curiously, not even one out of the 200 shells was found in spite of a prolonged and careful search under and amongst coral rocks and slabs. On the following day a search for the numbered shells in the adjoining reefs up to a depth of about 4 fathoms was made from a row-boat with the help of a water-glass (a pyramidal, trumpet-shaped wooden structure with a plate-glass, fixed to the broader end, acting as the window), but failed to reveal any of the marked shells. They had apparently moved down to greater depths in search of food and shelter. It may be mentioned that on that side of the Ross I., there were abundant growths of branching Madreporarian corals which rendered examination of the bottom at depths below 4 fathoms extremely difficult.

The growth experiment was, however, recommenced about the end of February 1933 with another 100 specimens between 5·0 and 7·0 cms. in diameter collected on the reefs off Little Andaman. As the declivous

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[1] All the measurements in respect of the shell of *Trochus niloticus* given in this paper refer only to the maximum diameter unless otherwise stated.

nature of the bottom on Ross I. rendered the recovery of marked shells difficult, a large shallow pit near South Point with coral boulders and slabs heaped along its periphery was selected for the experiment, and the shells bearing a vertical file-mark, 5 mm. high and 2 mm. deep, on the outer lip one centimetre from the growing edge of the mouth were deposited in the crevices between the dead coral masses at the bottom of the pit. The diameter of the shells was recorded. It was observed that on a second visit to that place in April 1933 most of the marked shells had crawled out of the pit to the rocks and coral boulders below low-tide level, while a few were found under stones between tide-marks within a radius of 20 yards from the pit. No attempt to gather and confine them again in the pit was made, but on subsequent monthly visits paid to that locality at favourable low tides, as many of the file-marked specimens as could be collected were brought together, and the length of the intervening space between the original file-mark and the growing edge of the mouth was directly measured with the help of a measuring tape.[1] The diameter of the shells was also noted. A fresh file-mark one centimetre from the edge of the mouth was made on the periphery of the last whorl every time marked shells were recovered from the reefs so that the number of occasions on which they were measured could be noted. The actual total growth along the whorls from the initial date of the experiment indicated by the first file-mark to the final date can be computed by subtracting 1 cm. from the measurement taken along the whorls from the first file-mark to the extreme edge of the growing outer lip of the mouth of the shell. During the S. W. monsoon season of 1933 no measurements could be taken on account of unfavourable weather conditions, and in October of that year it was found that there were less than a dozen specimens of the 100 marked shells with which the experiment was started, all the remaining individuals having either migrated into deeper waters or been killed by adverse conditions in their environment. For want of adequate funds, the fencing off of a part of the experimental area with a view to prevent the migration of the animals into the deeper parts of the reef could not be arranged. The observations were, however, continued till July 1935 on the few individulas that remained in the accessible parts of the reef, in addition to a fresh set of observations which was commenced in February 1934.

The results obtained from a study of growth in the file-marked shells appeared to be of some interest. There was a more or less definite correlation between growth along the whorls and growth in diameter of the shell, and it became evident that the relationship between the two types of growth could be expressed by the formula $\frac{W}{D} = C$, where W represents the length of whorls of a shell measured from the outer edge of the mouth along the periphery of the last whorl and thence along the suture to the topmost point of the spire, and D the maximum diameter of the shell, and C the constant. This constant, which is based on the average of a large series of (nearly 400) measurements of shells

[1] This measurement less 1 cm. gives the extent of growth along the whorls in the period between the dates of the original and subsequent measurements.

of all sizes, is 8·7.[1] In the absence of serial numbers on the shells which would enable the identification of individuals at various stages of this study, it seemed to me that this formula would have a practical application in determining the diameter of a shell at given stages or dates of the study from data relating to growth along the whorls. A concrete example would explain the application better. On a given date the diameter of a shell under observation is 9·9 cms. as measured directly by callipers, and the actual growth along the periphery of the last whorl (from a previous recorded date) as measured directly by a graduated tape from the first file-mark to the edge of the outer lip of the mouth is 30·0 cms. The diameter of the shell on the previous date which is unknown can be calculated as shown below:

The length of the entire whorls of a shell 9·9 cms. in diameter can be found by the use of a variant of the formula given above, *e.g.*, $D \times C = W$; thus the length of whorls of this shell should be $9{\cdot}9 \times 8{\cdot}7 = 86{\cdot}03$ cms.; the actual growth along the whorls, 30·0 cms.—1·0 cm. (being the distance between edge of lip and the latest file-mark)=29·0 cms. The length of the entire whorls on the previous date should have been therefore 86·13 cms.—29·0 cms.=57·13 cms. Using another variant of the formula, *e.g.*, $\frac{W}{C} = D$, the diameter of the shell at the time of previous observation should have been $\frac{57{\cdot}13}{8{\cdot}7} = 6{\cdot}56$ cms. Now that the present and previous diameters are known, the total growth in diameter between the two given dates of observation is, in this example, 9·90—6·56 cms.=3·36 cms. The agreement in results between the indirect method of calculating the growth in diameter of a shell as outlined above, and the direct method of measuring growth in diameter from a record of growth of numbered shells to be detailed in another paragraph, has been verified in respect of two shells which bore a series of file-marks and a serial number. The error between the two methods was in one case 0·02 and in the other 0·10.

A series of observations on growth of shell in reference to length of whorls was taken from the 27th February, and again from the 20th October, of the year 1933, but owing to the gradual decrease in the number of file-marked shells due to loss of specimens, and to the involved manner of calculating the rate of growth in diameter, this method of observation was abandoned. The data obtained are, however, given in Tables I and II which show that there is a considerable variation in the rate of growth of individuals of approximately the same size.[2] Even so, the results indicate clearly that the monthly rate of growth declines as the shell increases in diameter.

The occurrence of certain oblique lines of growth (pl. XIV, figs. 3-5) on the periostracum of the whorls of shells suggested another line of investigation of the rate of growth which has often been followed with

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[1] The indices or constants for different sizes of shells from 2·0 cms. to 12·99 cms. in maximum diameter, on statistical analysis, showed that the means of indices for the different sizes were significantly different from one another. For the purpose, however, of a rough estimate of the rate of growth in *T. niloticus*, a single index or constant based on observations for all sizes of shell was deemed sufficient.

[2] Russel (*loc. cit.*, p. 243) observed similar variations in the rate of growth of *Patella vulgata* on the British coasts, and Moorhouse (*loc. cit.*, p. 153, 1932) in that of *Trochus niloticus* on the Queensland coast.

success in the study of growth in certain Lamellibranchs. The oblique lines of growth were found usually on the membranous organic periostracal layer, but in some shells they extended down to the pearly layer (pl. XIV, fig. 3). Closer examination of a large series of shells above 7 cms. in diameter revealed the fact that the lines of growth were spaced irregularly and clearly discernible only on the last two whorls of the shell and that in young shells with a diameter of 5 cms. and below, they were either absent, or, if present, not so clearly seen as in adult shells.[1] The lines of growth, each representing what was at one time the growing edge of the shell, seen on shells of *Trochus niloticus* of 7-10 cms. diameter are at varying distances from one another, but usually under 1 cm. along the periphery of the whorls. In fresh shells in which the periostracal layer is intact there are minute but distinct breaks at intervals in the continuity of this layer indicating the positions in which growth has been interrupted. Along these oblique lines, the periostracal layer is also slightly turned up. There are usually 12-14 lines on the last whorl of shells of the 7 cm. group, and more than 20 lines on that of shells of the 10 cm. group. It is fairly obvious from the results of the study of growth in this species by other methods, that a single line does not represent a break or interruption in growth once a year, that is to say, that the lines do not correspond to the annual rings observed on the shells of Lamellibranchs, and on the scales and otoliths of Fish in temperate waters where the physical conditions of growth during winter are such as to stop growth for a period. The lines on the shell of *T niloticus* may represent rhythmic or periodic interruptions in growth, oftener than once a year correlated with an internal rhythm characteristic of the species, with the phases of the moon or with other factors little understood at present. The value of the annual ring method in estimating the age of various Molluscs is discussed by Weymouth (1923), who shows that there is no unamity on the part of workers in regard to the reliability of the method. So far as *T niloticus* is concerned the study of the rate of growth and of age by using the lines of growth on the shell as the criterion does not seem to give satisfactory results. The attempt, therefore, to study the rate of growth in the shell with the oblique lines of growth present on the whorls as the criterion, was given up.

A fresh set of observations was commenced in February 1934 to study the rate of growth of the shell with its maximum diameter as the criterion for growth. 77 specimens of various sizes from 3 to 9 cms. in diameter collected in the vicinity of South Corbyn's Cove, Port Blair, and in North Andamans, were serially numbered with Indian ink on the periostracum of the base of the body whorl and on the surface of the mouth and the umbilicus. After recording the diameter of each of the numbered shells, they were left in the crevices between coral masses covered with growths of algae in the area immediately north of the pier bearing the South Point Navigation Light, Port Blair (pl. XIV, fig. 2). The area was more or less protected from wind and currents by Ross I. on the east and by the solid rocky pier on the south ; and the

[1] In adult shells over 10·0 cms. in diameter, the lines of growth were frequently masked by algae, and animals such as limpets, barnacles, worms and boring molluscs, and in scraping these off the periostracal layer bearing the lines of growth could not be preserved.

sandy bay on the west and north prevented the migration of individuals in these two directions. Once or twice a month the area was visited at favourable low-tide periods, and as many numbered shells as could be recovered from under the stones and rocks before the rise of the tide were collected, and their diameter recorded. It was sometimes found necessary to re-write the numbers on some shells as the ink-marks were rubbed off by the mechanical action of the rough surfaces of rocks and boulders coming into contact with the lower surface of the last whorl of the shell of the animals in the course of their migrations. Foreign organisms such as algae, worms, molluscs, barnacles, etc., which attach themselves to the surface of the whorls of the spire in a very short time prevented the marking of shells on the whorls. The numbers marked in Indain ink on the nacreous surface of the mouth and the umbilicus of the shell were, however, often preserved permanently by a thin layer of nacre covering the original surface on which the ink-marks had been made at the commencement of the observations. Owing to the thinness and transparency of the overlying nacre, however, the marks were quite visible. In young shells where growth was rapid the marks on the mouth of the shell were hidden from view by the growing last whorl, and the numbers had to be re-written from time to time on the nacreous layer of the fresh growing parts of the mouth of the shell. To make up for the loss of experimental individuals due to migration into deeper waters, to death, or to other causes, fresh individuals obtained from other localities and numbered serially with the original lot of 77 shells were added from time to time. Thus at the conclusion of the growth observations in July 1935 the total number of shells marked for the experiment had increased from 77 to 635. On different visits to the area at intervals of 2 weeks to one month, the percentage number of marked shells recovered from under the rocks and boulders between tide-marks varied from as low a figure as 5 to 45. A large number of shells which was never recovered may have migrated into deeper waters or fallen a prey to their natural enemies. Some were found almost every month, while others were found at intervals varying from one to five months. When shells were found after a period of 4 or 5 months the ink-marks, except where protected by a thin layer of nacreous deposit, were undecipherable, and the shells could not be used again in the experiment unless they were regarded as fresh individuals and marked with new numbers. A continuous record of growth in the shell was obtained in the case of only 2 or 3 individuals.

With the closing of the *Trochus* Fishery investigations in July 1935 under orders of the Government, the growth observations were also stopped. A thorough search on the reefs near South Point, Port Blair, between tide-marks, and at depths upto 3 to 4 fathoms with the assistance of professional divers was made for the numbered shells, and as many of them as could be collected on the days of search were brought ashore. After recording the maximum diameter of the shells obtained each of them was broken open and the contents of the gonads examined to determine the sex. In doubtful cases where the sex elements were not fully developed, the gonads were suitably preserved and later sectioned for microscopic examination.

A careful study of the data[1] thus collected seemed to confirm what has been stated in a previous paragraph (*vide* p. 476), that the rate of growth in the shell bears a definite relation to the age of the specimen which may be expressed in terms of the maximum diameter of the shell. At what stages in the life-period of the species the rate of growth changes cannot be determined satisfactorily, but for purposes of this study it may be assumed that the rate of growth falls when an individual passes from one size-category to the next higher, whatever the length of the period intervening between the two consecutive stages. Thus two shells 2·99 cms. and 2·74 cms. in diameter respectively (falling within the group 2·00 cms.—2·99 cms.) which pass to the next higher stage, *e.g.*, 3·23 cms. and 3·27 cms. respectively (within the group 3·00 cms.—3·99 cms.) in approximately $\frac{1}{2}$ to $1\frac{1}{2}$ months respectively, will have their rate of growth lowered when passing from the lower size-category to the next higher.

Growth in marine animals is governed by various physical, chemical and biological conditions in their environment. A study of the habits of *Trochus niloticus* has shown that it feeds almost exclusively on marine algae and bottom deposits.[2] The growth of marine algae of the littoral zone is in turn governed by several factors such as light, the salinity of water, the nature of the bottom, strength of currents, etc., but amongst these light is known to be the most important factor. In the Andamans and Nicobars with a heavy annual rainfall distributed over the two monsoons of nearly 7 months' duration the amount of sunlight received, and the quantities of freshwater drained into the sea from tho adjoining steep hill-sides are apt to vary and influence the growth of algae in the littoral zone. It was, therefore, thought that, in studying the growth of this species, it would be of value to take into consideration the influence of the seasons, as with the abundant growth of algae during the sunny months the increased availability of food may enhance the chances of growth of the individuals of the species.[3] The mean monthly figures for cloud amount, rainfall, and number of rainy days for Port Blair and for Indian Standard Time, given in the monthly weather reports of the Indian Meteorological Department for 1935, provided convenient criteria for dividing a year into two seasons, namely, the period of heavy rainfall from May to November, and the period of a comparatively scanty rainfall and of bright sunshine from December to April. The latter season is also the more favourable from the point of view of the divers for whom visibility of the bottom is one of the prime factors for success in their operations.

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[1] Although the records of measurements of 510 numbered shells over a period of growth of 18 months were available, the number of shells recovered at the conclusion of the study, the sex of which was known, was only 119. But as each of these 119 specimens had passed through 2 to 4 stages or categories of shell-size (*vide* Table III) in the course of growth, there were actually 301 readings of the rates of growth for analytical study.

[2] The habits of *Trochus niloticus* are dealt with more fully in another paper to be published in this journal shortly.

[3] Orr, A. P. (*Sci. Rep. Great Barrier Reef Exped.* 1928-29, II, No. 3, pp. 37-86, 1933), comparing the results of his hydrographical investigations in the seas in the neighbourhood of the Great Barrier Reef with those of other parts of the tropics, came to tho conclusion that there is a considerable uniformity in the physical and chemical conditions of tropical seas, and that seasonal variations, if any, are negligible.

In assigning each of the 301 examples of various sizes and of both sexes under observation to its appropriate season, a certain degree of overlapping of the period of growth over the two consecutive seasons has been inevitable (see Table III). For instance, a shell of 9·32 cms. diameter numbered in the month of August and left for growth in the experimental area which passed on to the 10 cm. size group in about 12 months will have its growth period distributed over both the seasons, and as, in this case, the greater part of the growth period was in the rainy season, from August to November and again from May to July, it was assigned to the season of heavy rainfall from May to November.

The monthly rate of growth of a shell was calculated by dividing the difference in diameter between two consecutive growth stages by the total period in fractions of months in which growth between these stages was completed.[1] The data of monthly rate of growth thus calculated in respect of the growth stages of all the numbered shells (see Tables IV and V) were statistically analysed to determine the influence of each of the factors of age, sex, and season on growth. The results of this study by Dr. K. C. K. E. Raja and myself which are embodied in a separate note following this paper indicate that while the mean rates of growth vary inversely with age, and the female grows faster than the male, the seasons do not seem to have a significant influence on growth. The present investigation seems to bear out Orr's (1933) conclusions that seasonal variations in the tropical seas are negligible.

The mean rates of growth of *Trochus niloticus* of both sexes as derived from statistical analyses are given below, but they pertain, however, to the six age-groups, 4·00–4·99 cms. to 9·00—9·99 cms. only, the growth data obtained for the smaller (below 4·00 cms.) and the larger (above 10·00 cms.) size- or age-groups being inadequate for purposes of statistical analysis.

Mean monthly rates of growth of Trochus niloticus.

Size- or Age-groups. (Max. diam. in cms.)	MALES.		FEMALES.	
	Dec.-Apr.	May-Nov.	Dec.-Apr.	May-Nov.
4—4·99	0·3155	0·3205	0·3342	0·3362
5—5·99	0·3079	0·3044	0·3122	0·3539
6—6·99 . .	0·2609	0·2824	0·2694	0·2934
7—7·99 . . .	0·2053	0·2140	0·2329	0·2129
8—8·99 . . .	0·1331	0·1460	0·1485	0·1592
9—9·99 . . .	0·0916	0·0900	0·1072	0·0945

Another problem to which a solution has been sought in the course of this study is that of the age up to which the species lives in the Andaman waters. The exact period [2] and frequency of breeding, the dura-

[1] Moorhouse (*Rep. Great Barrier Reef Committee*, IV, pt. i, p. 26, 1933) calculated the yearly rate of growth of two individuals of *T. niloticus* which had been found after 2½ years from the date of the commencement of his study. One had passed from the 5·0 cm. stage to the 9·0 cm. stage and the other from the 4·0 cm. stage to the 10·0 cm. stage, skipping over 4 and 6 growth stages respectively. He did not apparently take into consideration the difference in the rates of growth between the successive stages within that period.

[2] Amirthalingam (1932) concluded from his observations that *Trochus niloticus* begins to spawn in the Andamans in April, while Moorhouse (1932) observed the same species in Low Isles spawning from March to July.

tion of development of the egg after fertilisation,[1] the length of larval life, the rate of growth of the very young animal between the close of larval life and the stage at which it reaches a diameter of 2 cms., and lastly the rate of growth of shell between the 11 and 14 cm. size-groups[2] would provide the requisite additional data to estimate the longevity of the species. But as the early and late history of its life is not fully known, a very approximate estimate alone is possible.

In the following table are given the average monthly rates of growth of shells of all sizes from 2·0 to 11·99 cms. in diameter irrespective of sex :—

Size- or Age-group.	No. of shells from which the average was derived.	Average monthly rates of growth in cms.[3]
2—2·99	19	0·39
3—3·99	61	0·33
4—4·99	43	0·33
5—5·99	57	0·32
6—6·99	61	0·28
7—7·99	61	0·22
8—8·99	40	0·15
9—9·99	19	0·10
10—10·99	18	0·06
11—11·99	7	0·04

Starting for example, with a shell of 2·0 cms. diameter, and applying the data given above in regard to growth, it would be easy to estimate the approximate period in which the shell will pass through each of the successive higher categories of sizes to the last 11 cm. age-group.

The 2 cms. shell will grow to (2+0·39×3) 3·17 cms. in 3 months.

The 3·17 cms. shell will grow to (3·17+0·33×3) 4·16 cms. in 3 months.

The 4·16 cms. shell will grow to (4·16+0·33×3) 5·15 cms. in 3 months.

The 5·15 cms. shell will grow to (5·15+0·32×3) 6·11 cms. in 3 months.

The 6·11 cms. shell will grow to (6·11+0·28×4) 7·23 cms. in 4 months.

The 7·23 cms. shell will grow to (7·23+0·22×4) 8·11 cms. in 4 months.

The 8·11 cms. shell will grow to (8·11+0·15×6) 9·01 cms. in 6 months.

The 9·01 cms. shell will grow to (9·01+0·10×10) 10·01 cms. in 10 months.

[1] Moorhouse (1932, p. 154) observed the first division of the fertilised egg in 4 hours, and ciliated embryos in 20 hours after fertilisation.

[2] Although large shells exceeding 12 cms. in diameter are very rare, a few of 14 cms. diameter have occasionally been fished in the Andaman and Nicobar seas.

[3] The mean rates of growth for the 2 and 3 cm., and 10 and 11 cm. categories of size of shell have been calculated from the available data on growth which were considered inadequate for statistical study.

The 10·01 cms. shell will grow to (10·01+0·06×17) 11·03 cms. in 17 months.

The 11·03 cms. shell will grow to (11·03+0·04×25) 12·03 cms. in 25 months.

The 2 cms. shell will therefore reach the 11—11·99 cms. stage in 78 months or 6½ years. Owing to the inadequacy of laboratory and aquarium facilities at Port Blair, it was not possible to study the growth of the shell below 2 cms. diameter under controlled conditions. Previous work by European authors on the smaller species of *Trochus* in temperate seas shows that the rate of growth in the early stages is subject to considerable variation. Robert (1903) showed that in the case of certain European species of *Trochus*, such as *T magus*, *T conuloides*, and *T striatus*, the veliger stage is reached in about 18 hours to one day, and found that the period of hatching from the eggs varied a great deal, from one day to about a week. He also observed that the young of *T magus*, developed in aquaria from eggs deposited on 24th June 1898, had attained a diameter of 2 cms. at the end of September of the following year. Pelseneer (1934) observed that in *T umbilicalis* the development of the egg takes place in 2 hours after fertilisation, and the 1·0 cm. stage is reached in 6 months. In regard to *Trochus niloticus* the rate of growth of the shell prior to the 2 cms. stage can only be guessed approximately from the results obtained for the higher age-groups between the 2·0 and 5·0 cms. stages. Allowing a period of about 2 or 3 months for the stages intervening between the shedding of the eggs and their fertilisation, and their subsequent development and growth up to 2 cms. in diameter, and a period of about 4 years for the stages intervening between the 12·0 and 14·0 cms. categories, the approximate longevity of the species under normal conditions of growth would exceed 10 years. Therefore a shell in its first year of growth will have a diameter up to 5·0 cms., in its second year a diameter ranging from 5·0 to 8·0 cms., in its third year a diameter ranging from 8·0 to 10·0 cms., in its fourth and fifth years a diameter ranging from 10·0 to 11·0 cms., in its sixth and seventh years a diameter ranging from 11·0 to 12·0 cms., and in its eight to eleventh years a diameter ranging from 12·0 to 14·0 cms. Pelseneer (1933) on the authority of Yonge (1930)[1] stated that *T niloticus* lives for 4 years, while his own observations on *T umbilicalis* led him to the conclusion that the latter species lives for about 5 years. Yonge's estimate was presumably based on the rate of growth studies by Moorhouse (*loc. cit.*) in the Low Isles of the Great Barrier Reef. The great disparity between Yonge's estimate and mine may be due to the differences in the environmental conditions in the Great Barrier Reef and in the Andaman seas which, presumably, influence the rate of growth. Moorhouse observed that in the Low Isles females of *Trochus niloticus* with shell-diameter between 4·0 and 8·0 cms. were laying eggs, and that conditions for normal growth were not favourable in some parts of the islands. Shells of diameter below 6·0 cms. observed to lay eggs were regarded by him as instances of retarded growth. In the Andamans, however, sexual maturity in females was, as a rule, observed

[1] This reference was not available to me in Calcutta.

in individuals with shell-diameter exceeding 9·0 cms., and although no actual instance of egg-laying was observed, only shells above 10 cms. diameter were often known to have eggs in the genital passages ready to be discharged.[1] Under these circumstances, it seems probable that the conditions for growth in the two regions, *e.g.*, the Queensland coast and the coasts around the Andamans are not similar. The difference in the estimates of longevity of the same species under, presumably, different conditions is, therefore, to be expected.

In conclusion, I take this opportunity to offer my sincere thanks to Mr. K. S. Misra who gave me ungrudging assistance throughout the period of this investigation in collecting and arranging the data of growth, and to my friend, Dr. K. C. K. E. Raja of the All-India Institute of Hygiene, Calcutta, for readily agreeing to analyse the results of my study from the statistical point of view.

SUMMARY.

1. The paucity of literature on the rate of growth in the Gastropoda is referred to.
2. The methods adopted in the study of the rate of growth in *Trochus niloticus* Linn. with the length of the whorls and the maximum diameter of the shell as the criteria for growth are described.
3. The relationship between growth in diameter and growth along the whorls of the shell expressed by a formula which suggested itself in the course of this study is explained.
4. The approximate agreement in the results obtained by the methods referred to in (2) above is pointed out.
5. A third method of studying growth in this species, using the lines of growth occurring on the lower whorls of the shell as the measure of the rate of growth, proved to be unsatisfactory because of the irregularity in their occurrence on the various whorls of the shell, and of the lines not representing any known seasonal interruption in growth.
6. From the records of the maximum diameter of individual shells, male and female, at each stage of their growth, and from the records of the season in which growth has taken place between each set of consecutive stages, the monthly rate of growth is derived. The monthly rates of growth thus obtained are statistically analysed.
7 The rate of growth of the shell varies inversely with age as determined by the maximum diameter of the shell between certain stages, and the female grows faster than the male, but seasons do not seem to have a significant influence on growth.
8. The longevity of *T niloticus* in the Andaman seas, estimated from the monthly rates of growth at each stage, and from other known facts of its life-history, appears to exceed 10 years. A shell in its first year of growth will have a diameter upto 5·0 cms., in its

[1] In another paper on the habits of *Trochus niloticus* which is to be published shortly, the sexual maturity of the gonads at various ages is fully discussed.

second year a diameter ranging from 5·0 to 8·0 cms., in its third year a diameter ranging from 8·0 to 10·0 cms., in its fourth and fifth years a diameter ranging from 10·0 to 11·0 cms., in its sixth and seventh years a diameter ranging from 11·0 to 12·0 cms., in its eighth to eleventh year a diameter ranging from 12·0 to 14·0 cms.

9. The variability in the rate of growth of various species of the Trochidæ is inferred from the existing works on the subject by other authors.
10. The noticeable variance in the estimates of longevity of *T niloticus* on the Queensland Coast of Australia and on the coasts of the Andamans in the Bay of Bengal is attributed to the difference in the conditions of growth in the two seas.

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TABLE I.

DATA OF GROWTH IN *Trochus niloticus* OF 27TH FEBRUARY, 1933, MEASURED IN TERMS OF THE LENGTH OF THE WHORLS, BUT CONVERTED TO REFER TO THE MAXIMUM DIAMETER OF THE SHELL.

(*Measurements in Centimetres.*)

Months in which growth readings were taken.	Original diameter calculated with the help of formula.	Present diameter.	Actual growth in diameter.	Monthly rate of growth.
August 1934	8·31	11·42	3·11	0·172
September „	8·31	11·42	3·11	0·166
October „	8·22	11·44	3·22	0·161
November „	8·22	11·44	3·22	0·158
December „	8·21	11·50	3·29	0·154
January 1935	8·32	11·54	3·22	0·144
February „	8·17	11·60	3·43	0·147
March „	8·17	11·60	3·43	0·143
April 1933 .	7·55	7·94	0·39	0·212
June „	7·24	8·30	1·06	0·318
August „	7·27	8·88	1·61	0·301
October „ .	7·37	9·48	2·11	0·275
November „ .	7·07	9·09	2·02	0·233
December „	7·36	9·71	2·35	0·243
February 1934 .	7·13	9·80	2·67	0·232
March „ .	7·14	9·87	2·73	0·216
April „ .	7·18	10·07	2·89	0·214
May „	7·17	10·00	2·82	0·192
June „ . .	7·09	10·43	3·34	0·208
July „	7·11	10·57	3·46	0·207
August „ .	7·11	10·44	3·33	0·186
September „	7·28	10·86	3·58	0·191
October „	7·16	10·85	3·69	0·188
November „	7·26	11·00	3·74	0·184
December „ .	7·16	11·05	3·89	0·182

TABLE I—*contd.*

Months in which growth readings were taken.	Original diameter calculated with the help of formula.	Present diameter.	Actual growth in diameter.	Monthly rate of growth.
January 1935	7·85	10·84	2·99	0·133
April ,,	7·92	11·55	3·63	0·143
May ,,	7·98	11·67	3·69	0·140
June ,, .	7·94	11·80	3·86	0·138
April 1933	6·54	7·06	0·52	0·285
June ,,	6·36	7·59	1·23	0·368
August ,,	6·41	8·13	1·72	0·324
September ,,	6·60	8·44	1·84	0·293
October ,,	6·51	8·53	2·02	0·269
November ,, .	6·40	8·97	2·57	0·321
December ,, .	6·49	8·75	2·26	0·223
January 1934	6·45	9·28	2·83	0·296
March ,, .	6·58	9·44	2·86	0·224
April ,, .	6·63	9·29	2·66	0·196
May ,, .	6·58	9·66	3·08	0·207
June ,,	6·72	9·93	3·21	0·200
July ,,	6·55	10·01	3·46	0·205
August ,,	6·65	10·03	3·38	0·189
September ,,	6·56	10·08	3·52	0·187
October ,,	6·44	10·13	3·69	0·186
November ,,	6·49	10·23	3·74	0·183
December ,,	6·62	10·38	3·76	0·175
January 1935	6·70	10·18	3·48	0·155
February ,,	6·41	10·35	3·93	0·168
March ,,	6·49	10·54	4·05	0·168
April ,,	6·48	10·62	4·14	0·163
May ,,	6·32	10·67	4·35	0·165
June ,,	6·25	10·68	4·43	0·159

TABLE I—*contd.*

Months in which growth readings were taken.	Original diameter calculated with the help of formula.	Present diameter.	Actual growth in diameter.	Monthly rate of rowth.
April 1933	5·58	6·10	0·52	0·284
June ,, .	5·68	6·80	1·12	0·336
August ,, .	5·23	7·07	1·84	0·345
November ,,	5·40	6·88	1·48	0·170
December ,, .	5·50	7·14	1·64	0·169
January 1934	5·42	7·49	2·07	0·195
June ,, .	5·99	9·39	3·40	0·212
September ,,	5·99	9·71	3·72	0·202
December ,,	5·97	10·00	4·03	0·188
February 1935	5·97	10·29	4·32	0·185
April 1933	4·59	5·10	0·51	0·280
June ,,	4·40	5·51	1·11	0·333
August ,,	4·73	6·39	1·66	0·310

TABLE II.

DATA OF GROWTH IN *Trochus niloticus* OF 20TH OCTOBER, 1933, MEASURED IN TERMS OF THE LENGTH OF THE WHORLS, BUT CONVERTED TO REFER TO THE MAXIMUM DIAMETER OF THE SHELL.

(*Measurements in Centimetres.*)

Months in which growth readings were taken.	Original diameter calculated with the help of formula.	Present diameter.	Actual growth in diameter.	Monthly rate of growth.
November 1933	9·40	9·52	0·12	0·120
January 1934	9·61	9·96	0·35	0·123
November 1933	8·72	8·90	0·18	0·180
December ,,	8·78	9·04	0·26	0·130
January 1934	8·65	9·23	0·58	0·204

TABLE II—*contd.*

Months in which growth readings were taken.	Original diameter calculated with the help of formula.	Present diameter.	Actual growth in diameter.	Monthly rate of growth.
March 1934	8·64	9·51	0·87	0·180
April ,,	8·62	9·60	0·98	0·168
May ,,	8·51	9·80	1·29	0·176
August ,,	8·57	10·10	1·53	0·150
September ,,	8·55	10·17	1·62	0·144
October ,,	8·57	10·27	1·70	0·139
November ,,	8·55	10·28	1·73	0·137
December ,, .	8·48	10·33	1·85	0·136
January 1935 .	8·44	10·38	1·94	0·132
February ,,	8·56	10·46	1·90	0·121
December 1933	7·16	7·74	0·58	0·292
April 1934	7·14	9·10	1·96	0·336
November 1933	6·62	6·90	0·28	0·285
December ,,	6·37	6·99	0·62	0·310
February 1934 .	6·12	7·40	1·28	0·365

TABLE III.

Table showing the history of growth of the numbered shells of *Trochus niloticus* between February 1934 and July 1935.

Mark or No. of shell of *Trochus*.	Maximum diameter in cms. of the shell at each stage of its growth.	Months in which the original and final measurements were taken.	Total period of growth in fractions of months.	Total growth in maximum diameter in cms. in this period.	Monthly rate of growth in cms.	Sex of individuals.
218	2·90	Aug.-Sept.	$1\frac{1}{3}$	0·57	0·427	♀
	3·47	Sept.-Jan.	$4\frac{1}{3}$	1·22	0·281	
	4·69	Jan.-May	4	1·19	0·297	
	5·88	May-July	$2\frac{1}{2}$	0·82	0·328	
290	2·88	Oct.-Nov.	$1\frac{1}{2}$	1·07	0·713	♂
	3·95	Nov.-Feb.	3	0·80	0·266	
	4·75	Feb.-May	$2\frac{2}{5}$	0·75	0·312	
	5·50	May-June	$1\frac{5}{6}$	0·61	0·332	

TABLE III—*contd.*

Mark or No. of shell of *Trochus*.	Maximum diameter in cms. of the shell at each stage of its growth.	Months in which the original and final measurements were taken.	Total period of growth in fractions of months.	Total growth in maximum diameter in cms. in this period.	Monthly rate of growth in cms.	Sex of individuals.
310	3·78	Oct.-Jan.	$3\frac{1}{2}$	1·18	0·337	♀
	4·96	Jan.-April	$2\frac{2}{5}$	0·96	0·400	
	5·92	April-June	2	0·74	0·370	
	6·66	June	1	0·40	0·400	
318	3·95	Oct.-Feb.	$3\frac{3}{5}$	0·90	0·250	♂
	4·85	Feb.-May	3	1·01	0·336	
	5·86	May-June	2	0·53	0·265	
7A	3·26	Nov.-Feb.	3	1·08	0·360	♀
	4·34	Feb.-June	$4\frac{1}{3}$	1·39	0·320	
13A	3·50	Nov.-Mar.	$3\frac{1}{2}$	1·37	0·391	♀
	4·87	Mar.-July	4	1·03	0·257	
16A	3·30	Nov.-May	$5\frac{2}{5}$	1·61	0·298	♀
	4·91	May-June	$1\frac{5}{6}$	0·77	0·420	
19A	3·10	Nov.-May	$5\frac{2}{5}$	1·62	0·300	♂
	4·72	May-June	$1\frac{5}{6}$	0·65	0·354	
35A	3·99	Dec.-Mar.	3	0·85	0·283	♀
	4·84	Mar.-May	2	0·58	0·290	
	5·42	May-July	2	0·79	0·395	
36A	3·40	Dec.-April	4	1·30	0·325	♀
	4·70	April-May	1	0·47	0·470	
	5·17	May-July	$2\frac{1}{2}$	0·93	0·372	
38A	3·64	Dec.-Apr.	4	1·26	0·315	♀
	4·90	Apr.-June	2	0·74	0·370	
	5·64	June	$\frac{5}{6}$	0·60	0·720	
39A	3·23	Dec.-Apr.	4	1·61	0·402	♀
	4·84	Apr.-June	$2\frac{2}{3}$	1·04	0·390	
56A	3·84	Dec.-June	$5\frac{1}{3}$	1·09	0·204	♂
	4·93	June	$\frac{5}{6}$	0·29	0·348	
61A	3·88	Dec.-Apr.	$3\frac{1}{3}$	1·02	0·306	♀
	4·90	Apr.-June	$2\frac{2}{3}$	0·88	0·330	
62A	3·93	Dec.-Feb.	$1\frac{2}{5}$	0·39	0·278	♀
	4·32	Feb.-June	4	1·65	0·412	
	5·97	June	$\frac{5}{6}$	0·26	0·312	
68A	3·54	Jan.-Apr.	3	0·93	0·310	♀
	4·47	Apr.-July	3	1·39	0·463	
85A	3·63	Jan.-May	$3\frac{1}{3}$	1·22	0·365	♀
	4·85	May-June	$1\frac{5}{6}$	0·52	0·283	
4	4·86	Feb.-May	$3\frac{1}{2}$	1·15	0·328	♂
	6·01	May-Jan.	$7\frac{1}{3}$	1·81	0·246	
	7·82	Jan.-June	$5\frac{4}{5}$	1·06	0·182	

TABLE III—*contd.*

Mark or No. of shell of *Trochus*.	Maximum diameter in cms. of the shell at each stage of its growth.	Months in which the original and final measurements were taken.	Total period of growth in fractions of months.	Total growth in maximum diameter in cms. in this period.	Monthly rate of growth in cms.	Sex of individuals.
125	4·70	May-Sept.	3½	1·20	0·343	♀
	5·90	Sept.-Dec.	3	1·02	0·340	
	6·92	Dec.-Mar.	3	0·92	0·306	
	7·84	Mar.-June	3⅔	1·00	0·272	
144	4·86	June-Sept.	3½	1·11	0·317	♀
	5·97	Sept.-Dec.	3	0·96	0·320	
	6·93	Dec.-Mar.	2⅓	0·80	0·343	
	7·73	Mar.-July	4½	0·96	0·213	
147	4·72	June-Oct.	3⅖	1·16	0·341	♂
	5·88	Oct.-Jan.	3	0·99	0·330	
	6·87	Jan.-May	4	1·10	0·275	
	7·97	May-July	2½	0·52	0·208	
180	4·72	July-Nov.	4	1·10	0·275	♂
	5·82	Nov.-Feb.	2½	0·82	0·328	
	6·64	Feb.-June	4	1·08	0·270	
	7·72	June-July	1½	0·36	0·240	
183	4·41	July-Jan.	5½	1·54	0·280	♀
	5·95	Jan.-Apr.	3	0·86	0·286	
	6·81	Apr.-July	3	1·04	0·346	
184	4·51	July-Jan.	5½	1·40	0·254	♀
	5·91	Jan.-May	4	1·04	0·260	
	6·95	May-June	2	0·43	0·215	
186	4·74	July-Nov.	3½	1·03	0·294	♂
	5·77	Nov.-Feb.	3	1·00	0·333	
	6·77	Feb.-June	4⅚	1·17	0·242	
200	4·99	July-Oct.	2½	0·91	0·364	♀
	5·90	Oct.-Jan.	3	1·04	0·346	
	6·94	Jan.-June	5⅗	1·69	0·301	
203	4·90	July-Nov.	3⅖	1·06	0·311	♂
	5·96	Nov.-Feb.	3	0·79	0·263	
	6·75	Feb.-June	4	1·06	0·265	
	7·81	June-July	1½	0·39	0·260	
246	4·13	Sept.-Mar.	6	1·74	0·290	♀
	5·87	Mar.-June	3	1·06	0·353	
	6·93	June-July	1	0·33	0·330	
291	4·21	Oct.-Apr.	6	1·77	0·295	♂
	5·98	Apr.-July	3	0·99	0·330	
248	4·96	Sept.-Dec.	3⅗	0·98	0·272	♀
	5·94	Dec.-June	5⅓	1·84	0·345	
	7·78	June	1	0·24	0·240	
311	4·25	Oct.-Mar.	4⅚	1·69	0·349	♀
	5·94	Mar.-Apr.	1	0·34	0·340	
	6·28	Apr.-July	3½	1·21	0·345	

TABLE III—*contd.*

Mark or No. of shell of *Trochus.*	Maximum diameter in cms. of the shell at each stage of its growth.	Months in which the original and final measurements were taken.	Total period of growth in fractions of months.	Total growth in maximum diameter in cms. in this period.	Monthly rate of growth in cms.	Sex of individuals.
316	4·50	Oct.-Mar.	$4\frac{4}{5}$	1·34	0·279	♂
	5·84	Mar.-June	3	1·03	0·343	
	6·87	June-July	$1\frac{1}{2}$	0·46	0·306	
346	4·52	Nov.-Mar.	$3\frac{1}{2}$	1·13	0·323	♀
	5·65	Mar.-May	2	0·84	0·420	
	6·49	May-June	2	0·75	0·375	
350	4·34	Nov.-Apr.	$4\frac{1}{2}$	1·54	0·342	♂
	5·88	Apr.-July	3	1·10	0·366	
352	4·11	Nov.-Apr.	$4\frac{1}{2}$	1·49	0·331	♀
	5·60	Apr.-June	$2\frac{5}{6}$	1·16	0·409	
378	4·64	Dec.-Apr.	$3\frac{1}{3}$	0·96	0·288	♂
	5·60	Apr.-July	$2\frac{5}{6}$	1·05	0·370	
379	4·75	Dec.-Apr.	$3\frac{1}{3}$	1·03	0·309	♂
	5·78	Apr.-July	$3\frac{1}{2}$	1·18	0·337	
393	4·63	Jan.-May	$3\frac{1}{3}$	0·92	0·276	♀
	5·55	May-June	$1\frac{5}{6}$	0·62	0·356	
383	4·57	Jan.-Apr.	3	0·92	0·306	♂
	5·49	Apr.-July	3	0·66	0·220	
407	4·57	Feb.-May	$2\frac{5}{6}$	0·90	0·317	♀
	5·47	May-July	$2\frac{1}{2}$	0·91	0·364	
40A	4·70	Dec.-Feb.	$2\frac{1}{2}$	0·85	0·340	♀
	5·55	Feb.-May	$2\frac{2}{5}$	0·97	0·404	
	6·52	May-July	$2\frac{1}{2}$	0·81	0·324	
42A	4·41	Dec.-Mar.	3	1·08	0·360	♂
	5·49	Mar.-June	3	1·11	0·370	
	6·60	June-July	$1\frac{1}{2}$	0·57	0·380	
95A	4·20	Feb.-June	4	1·60	0·400	♀
	5·80	June-July	$1\frac{1}{2}$	0·41	0·273	
58	5·57	Feb.-Aug.	$5\frac{5}{6}$	1·32	0·226	♂
	6·89	Aug.-Dec.	$3\frac{5}{6}$	0·97	0·253	
	7·86	Dec.-June	$6\frac{1}{3}$	1·02	0·157	
65	5·91	Feb.-May	$2\frac{4}{5}$	0·74	0·264	♀
	6·65	May-Sept.	$4\frac{1}{2}$	1·20	0·266	
	7·85	Sept.-Jan.	$2\frac{2}{5}$	1·01	0·297	
	8·86	Jan.-June	$5\frac{3}{5}$	0·85	0·151	
127	5·55	May-Oct.	$4\frac{2}{5}$	1·31	0·297	♀
	6·86	Oct.-Feb.	4	0·93	0·232	
	7·79	Feb.-July	$5\frac{2}{5}$	0·82	0·152	
129	5·60	May-Nov.	$5\frac{1}{3}$	1·29	0·242	♂
	6·89	Nov.-June	$7\frac{4}{5}$	1·01	0·129	

TABLE III—*contd.*

Mark or No. of shell of *Trochus*.	Maximum diameter in cms. of the shell at each stage of its growth.	Months in which the original and final measurements were taken.	Total period of growth in fractions of months.	Total growth in maximum diameter in cms. in this period.	Monthly rate of growth in cms.	Sex of individuals.
135	5·10	June-Nov.	$5\frac{2}{3}$	1·89	0·333	♀
	6·99	Nov.-Feb.	$2\frac{1}{2}$	0·70	0·280	
	7·69	Feb.-June	$4\frac{3}{5}$	1·01	0·220	
139	5·48	June-Oct.	$4\frac{5}{6}$	1·44	0·298	♂
	6·92	Oct.-Feb.	$3\frac{2}{5}$	0·93	0·273	
	7·85	Feb.-July	5	1·12	0·224	
140	5·15	June-Nov.	$5\frac{2}{3}$	1·67	0·294	♂
	6·82	Nov.-Mar.	$3\frac{1}{2}$	0·93	0·265	
	7·75	Mar.-June	$3\frac{2}{3}$	0·71	0·193	
143	5·11	June-Dec.	6	1·73	0·288	♂
	6·84	Dec.-Apr.	4	1·07	0·267	
	7·91	Apr.-July	$3\frac{1}{2}$	0·65	0·185	
169	5·72	July-Nov.	$4\frac{1}{3}$	1·22	0·281	♀
	6·94	Nov.-Apr.	$4\frac{1}{2}$	0·98	0·217	
	7·92	Apr.-July	3	0·49	0·163	
174	5·65	July-Nov.	$4\frac{1}{3}$	1·12	0·281	♀
	6·77	Nov.-Feb.	$2\frac{1}{2}$	0·58	0·232	
	7·35	Feb.-July.	$5\frac{2}{5}$	1·10	0·203	
178	5·43	July-Nov.	$4\frac{1}{3}$	1·51	0·348	♂
	6·94	Nov.-Feb.	$2\frac{1}{2}$	0·81	0·324	
	7·75	Feb.-July	5	1·19	0·238	
199	5·86	July-Nov.	$3\frac{2}{5}$	1·11	0·326	♀
	6·97	Nov.-Feb.	3	0·92	0·302	
	7·89	Feb.-June	$4\frac{5}{6}$	1·05	0·217	
220	5·22	Aug.-Mar.	$6\frac{1}{3}$	1·56	0·246	♂
	6·78	Mar.-June	$3\frac{2}{3}$	1·04	0·283	
221	5·11	Aug.-Jan.	5	1·83	0·366	♀
	6·94	Jan.-Apr.	$2\frac{2}{5}$	0·78	0·300	
	7·72	Apr.-June	$2\frac{2}{3}$	0·76	0·285	
254	5·48	Sept.-Jan.	4	1·21	0·302	♂
	6·69	Jan.-May	4	1·16	0·290	
	7·85	May-June	$1\frac{2}{3}$	0·29	0·174	
256	5·81	Sept.-Jan.	4	1·16	0·290	♀
	6·97	Jan.-Apr.	3	0·96	0·320	
	7·93	Apr.-July	$3\frac{1}{2}$	0·97	0·277	
267	5·56	Sept.-Feb.	5	1·41	0·282	♂
	6·97	Feb.-May	$2\frac{2}{5}$	0·76	0·316	
	7·73	May-June	2	0·47	0·235	
275	5·41	Sept.-Mar.	$5\frac{1}{3}$	1·45	0·271	♂
	6·86	Mar.-June	$3\frac{2}{3}$	1·05	0·286	
308	5·12	Oct.-Apr.	$5\frac{5}{6}$	1·82	0·312	♂
	6·94	Apr.-June	2	0·75	0·375	
	7·69	June-July	$1\frac{1}{2}$	0·33	0·220	

TABLE III—*contd.*

Mark or No. of shell of *Trochus*.	Maximum diameter in cms. of the shell at each stage of its growth.	Months in which the original and final measurements were taken.	Total period of growth in fractions of months.	Total growth in maximum diameter in cms. in this period.	Monthly rate of growth in cms.	Sex of individuals.
314	5·93 6·86 7·78	Oct.-Jan. Jan.-Apr. Apr.-June	3 3 $2\frac{2}{3}$	0·93 0·92 0·75	0·310 0·306 0·281	♀
323	5·60 6·72 7·88	Oct.-Feb. Feb.-June June-July	$3\frac{3}{5}$ 4 $1\frac{1}{2}$	1·12 1·16 0·40	0·311 0·290 0·266	♂
349	5·77 6·79	Nov.-May May-July	$5\frac{1}{2}$ $2\frac{1}{2}$	1·02 0·69	0·185 0·276	♀
380	5·50 6·30	Dec.-Mar. Mar.-July	$2\frac{1}{3}$ $4\frac{1}{2}$	0·80 1·63	0·342 0·362	♂
41A	5·37 6·91	Dec.-May May-June	5 $1\frac{5}{6}$	1·54 0·56	0·308 0·305	♀
44	6·17 7·98 8·57	Feb.-Oct. Oct.-Jan. Jan.-June	$8\frac{1}{3}$ $2\frac{2}{5}$ $5\frac{3}{5}$	1·81 0·59 0·68	0·217 0·245 0·121	♂
136	6·15 7·76	June-Jan. Jan.-June	$7\frac{1}{3}$ $5\frac{3}{5}$	1·61 1·13	0·219 0·201	♀
137	6·64 7·92 8·94	June-Oct. Oct.-Mar. Mar.-June	$4\frac{5}{6}$ $4\frac{1}{3}$ $3\frac{2}{3}$	1·28 1·02 0·52	0·265 0·235 0·142	♂
152	6·81 7·98 8·65	June-Nov. Nov.-Feb. Feb.-June	$4\frac{2}{5}$ 3 $4\frac{3}{5}$	1·17 0·67 0·79	0·266 0·223 0·171	♀
157	6·37 7·89	June-Feb. Feb.-June	$7\frac{1}{3}$ $4\frac{3}{5}$	1·52 0·80	0·207 0·174	♂
193	6·99 7·96 8·74	July-Nov. Nov.-Feb. Feb.-June	$3\frac{5}{6}$ $2\frac{1}{2}$ $4\frac{3}{5}$	0·97 0·78 0·64	0·253 0·312 0·139	♀
196	6·51 7·79 8·87	July-Jan. Jan.-June June-July	$5\frac{2}{5}$ 5 1	1·28 1·08 0·17	0·237 0·216 0·170	♀
197	6·75 7·79	July-Dec. Dec.-June	$4\frac{2}{5}$ $6\frac{3}{5}$	1·04 1·14	0·236 0·172	♂
222	6·13 7·88	Aug.-Apr. Apr.-June	$7\frac{1}{3}$ $2\frac{2}{3}$	1·75 0·56	0·238 0·210	♂
224	6·60 7·88	Aug.-Mar. Mar.-June	$6\frac{1}{3}$ $3\frac{2}{3}$	1·28 0·67	0·202 0·182	♂
198	6·75 7·95 8·85	July-Dec. Dec.-Apr. Apr.-June	$4\frac{2}{5}$ 4 $2\frac{2}{3}$	1·20 0·90 0·24	0·272 0·225 0·090	♂

TABLE III—*contd.*

Mark or No. of shell of *Trochus*.	Maximum diameter in cms. of the shell at each stage of its growth.	Months in which the original and final measurements were taken.	Total period of growth in fractions of months.	Total growth in maximum diameter in cms. in this period.	Monthly rate of growth in cms.	Sex of individuals.
223	6·61	Aug.-Jan.	$4\frac{2}{5}$	1·31	0·297	♀
	7·92	Jan.-Apr.	3	0·96	0·320	
	8·88	Apr.-June	$2\frac{2}{3}$	0·62	0·232	
255	6·02	Sept-Apr.	6	1·86	0·272	♂
	7·88	Apr.-July	3	0·63	0·210	
250	6·80	Sept.-Apr.	7	1·14	0·162	♀
	7·94	Apr.-June	$2\frac{2}{3}$	0·45	0·168	
257	6·75	Sept.-Mar.	5_{6}	1·00	0·171	♀
	7·75	Mar.-June	$3\frac{2}{3}$	0·61	0·166	
272	6·75	Sept.-Feb.	$4\frac{1}{2}$	1·20	0·266	♀
	7·95	Feb.-July	5	0·80	0·160	
279	6·58	Sept.-Apr.	$6\frac{1}{3}$	1·40	0·221	♀
	7·98	Apr.-June	$2\frac{3}{5}$	0·41	0·153	
348	6·24	Nov.-Apr.	$4\frac{1}{2}$	1·52	0·337	♀
	7·76	Apr.-June	$2\frac{2}{3}$	0·72	0·270	
357	6·42	Dec.-June	$5\frac{1}{2}$	1·54	0·280	♀
	7·96	June	$\frac{2}{3}$	0·04	0·060	
68	7·02	Feb. 1934-Feb. 1935.	$11\frac{2}{3}$	1·96	0·168	♂
	8·98	Feb.-June	$4\frac{1}{2}$	0·21	0·046	
71	7·70	Feb.-Nov.	$9\frac{1}{6}$	1·28	0·139	♂
	8·98	Nov.-Feb.	$2\frac{1}{2}$	0·30	0·120	
	9·28	Feb.-July	$5\frac{2}{5}$	0·73	0·135	
86	7·74	Apr.-Sept.	5	0·99	0·198	♂
	8·73	Sept.-Apr.	6_{6}	1·19	0·174	
	9·92	Apr.-June	$2\frac{3}{5}$	0·14	0·054	
88	7·45	Apr.-Oct.	$6\frac{2}{5}$	1·51	0·236	♂
	8·96	Oct.-May	$6\frac{1}{3}$	0·98	0·154	
	9·94	May-June	$1\frac{3}{5}$	0·15	0·093	
172	7·32	July-Jan.	5^{8}	1·47	0·252	♀
	8·79	Jan.-July	6	0·76	0·126	
181	7·14	July-Mar.	$7\frac{2}{5}$	1·85	0·250	♀
	8·99	Mar.-July	4	0·55	0·137	
187	7·77	July-Feb.	$6\frac{2}{5}$	1·16	0·181	♀
	8·93	Feb.-June	$4\frac{3}{5}$	0·54	0·117	
116	7·74	May-Oct.	5	1·19	0·238	♀
	8·93	Oct.-Apr.	$5\frac{5}{6}$	1·01	0·173	
	9·94	Apr.-June	$2\frac{3}{5}$	0·20	0·077	
194	7·13	July-Apr.	$8\frac{1}{3}$	1·60	0·192	♂
	8·73	Apr.-June	$2\frac{2}{3}$	0·30	0·112	

TABLE III—*contd.*

Mark or No. of shell of *Trochus*.	Maximum diameter in cms. of the shell at each stage of its growth.	Months in which the original and final measurements were taken.	Total period of growth in fractions of months.	Total growth in maximum diameter in cms. in this period.	Monthly rate of growth in cms.	Sex of individuals.
226	7·82 8·91	Aug.-Mar. Mar.-June	$6\frac{1}{3}$ $3\frac{2}{3}$	1·09 0·37	0·172 0·101	♀
228	7·49 8·83	Aug.-Feb. Feb.-June	$5\frac{2}{5}$ $4\frac{5}{6}$	1·34 0·82	0·248 0·169	♂
230	7·79 8·88	Aug.-Mar. Mar.-July	$6\frac{1}{3}$ $4\frac{1}{2}$	1·09 0·53	0·172 0·117	♂
251	7·33 8·88	Sept.-Mar. Mar.-June	6 4	1·55 0·66	0·258 0·165	♂
258	7·39 8·79	Sept.-Apr. Apr.-July	$6\frac{5}{6}$ $3\frac{1}{2}$	1·40 0·40	0·205 0·114	♀
271	7·59 8·67	Sept.-Feb. Feb.-June	$4\frac{1}{2}$ $4\frac{5}{6}$	1·08 0·67	0·240 0·138	♂
302	7·95 8·68	Oct.-Jan. Jan.-July	3 $6\frac{2}{5}$	0·73 1·12	0·243 0·143	♂
387	7·95 8·86	Jan.-May May-June	4 $1\frac{2}{3}$	0·91 0·32	0·227 0·192	♀
404	7·86 8·52	Feb.-May May-July	$2\frac{5}{6}$ $2\frac{1}{2}$	0·66 0·48	0·233 0·192	♂
74	8·75 9·82	Feb.-Jan. Jan.-June	$10\frac{2}{3}$ $5\frac{3}{5}$	1·07 0·43	0·100 0·076	♂
93	8·50 9·92	Apr.-Dec. Dec.-June	$7\frac{5}{6}$ $6\frac{1}{2}$	1·42 0·64	0·181 0·098	♀
96	8·54 9·97	Apr.-Jan. Jan.-June	$8\frac{5}{6}$ $5\frac{3}{5}$	1·43 0·42	0·162 0·075	♂
111	8·62 9·93	May-Mar. Mar.-June	$9\frac{5}{6}$ $3\frac{3}{5}$	1·31 0·31	0·133 0·086	♀
112	8·12 9·98	May-Apr. Apr.-July	$10\frac{5}{6}$ $3\frac{1}{2}$	1·86 0·28	0·171 0·080	♂
114	8·93 9·92	May-Oct. Oct.-June	$5\frac{1}{2}$ 8	0·99 0·91	0·180 0·113	♂
115	8·76 9·81	May-Dec. Dec.-June	7 $6\frac{1}{2}$	1·05 0·76	0·150 0·117	♂
150	8·00 9·87	June-Apr. Apr.-June	$9\frac{1}{3}$ $2\frac{3}{5}$	1·87 0·23	0·200 0·088	♂
155	8·47 9·99	June-Apr. Apr.-June	$9\frac{1}{3}$ $2\frac{2}{3}$	1·52 0·33	0·163 0·123	♀
170	8·92 9·72	July-Feb. Feb.-June	$6\frac{5}{6}$ $4\frac{1}{2}$	0·80 0·35	0·117 0·077	♂

TABLE III—*concld.*

Mark or No. of shell of *Trochus.*	Maximum diameter in cms. of the shell at each stage of its growth.	Months in which the original and final measurements were taken.	Total period of growth in fractions of months.	Total growth in maximum diameter in cms. in this period.	Monthly rate of growth in cms.	Sex of individuals.
188	8·27 9·39	July-Feb. Feb.-July	$6\frac{2}{5}$ $5\frac{2}{5}$	1·12 0·84	0·175 0·155	♀
192	8·61 9·80	July-Mar. Mar.-June	$7\frac{1}{3}$ $3\frac{2}{3}$	1·19 0·37	0·162 0·073	♀
270	8·65 9·94	Sept.-May May-June	$7\frac{2}{5}$ $1\frac{2}{3}$	1·29 0·10	0·173 0·060	♀
154	9·73 10·72	June-Mar. Mar.-June	$8\frac{1}{3}$ $3\frac{3}{5}$	0·99 0·33	0·118 0·091	♀
243	9·93 10·84	Aug.-Apr. Apr.-June	$7\frac{1}{3}$ $2\frac{3}{5}$	0·91 0·22	0·124 0·084	♀

TABLE IV.

MONTHLY RATES OF GROWTH OF *Trochus niloticus* IN CENTIMETRES.

(*Males.*)

Size-groups (Max. diam. in cms.).	Season—December to April.	Season—May to November.
2—2·99	....	(1) 0·713.
3—3·99	(1) 0·300 (2) 0·266 (3) 0·250 (4) 0·204.	....
4—4·99	(1) 0·312 (2) 0·336 (3) 0·328 (4) 0·342 (5) 0·309 (6) 0·306 (7) 0·360 (8) 0·295 (9) 0·279 (10) 0·288.	(1) 0·354 (2) 0·348 (3) 0·341 (4) 0·311 (5) 0·275 (6) 0·294.
5—5·99	(1) 0·330 (2) 0·328 (3) 0·333 (4) 0·343 (5) 0·312 (6) 0·311 (7) 0·342 (8) 0·263 (9) 0·246 (10) 0·271.	(1) 0·332 (2) 0·330 (3) 0·366 (4) 0·370 (5) 0·337 (6) 0·370 (7) 0·348 (8) 0·302 (9) 0·265 (10) 0·220 (11) 0·226 (12) 0·242 (13) 0·298 (14) 0·294 (15) 0·288 (16) 0·282.
6—6·99	(1) 0·324 (2) 0·316 (3) 0·275 (4) 0·270 (5) 0·242 (6) 0·273 (7) 0·265 (8) 0·267 (9) 0·290 (10) 0·290 (11) 0·238 (12) 0·202 (13) 0·272 (14) 0·129.	(1) 0·306 (2) 0·380 (3) 0·375 (4) 0·362 (5) 0·246 (6) 0·265 (7) 0·253 (8) 0·283 (9) 0·286 (10) 0·217 (11) 0·265 (12) 0·207 (13) 0·236 (14) 0·272.

TABLE IV—*contd.*

Size-groups (Max. diam. in cms.).	Season—December to April.	Season—May to November.
7—7·99	(1) 0·245 (2) 0·235 (3) 0·225 (4) 0·258 (5) 0·233 (6) 0·182 (7) 0·157 (8) 0·174 (9) 0·172 (10) 0·172.	(1) 0·208 (2) 0·240 (3) 0·260 (4) 0·224 (5) 0·238 (6) 0·235 (7) 0·220 (8) 0·266 (9) 0·210 (10) 0·210 (11) 0·236 (12) 0·248 (13) 0·240 (14) 0·243 (15) 0·193 (16) 0·185 (17) 0·174 (18) 0·182 (19) 0·168 (20) 0·139 (21) 0·198 (22) 0·192.
8—8·99	(1) 0·121 (2) 0·120 (3) 0·174 (4) 0·154 (5) 0·169 (6) 0·138 (7) 0·143 (8) 0·046.	(1) 0·200 (2) 0·142 (3) 0·112 (4) 0·117 (5) 0·165 (6) 0·192 (7) 0·100 (8) 0·162 (9) 0·171 (10) 0·180 (11) 0·150 (12) 0·117 (13) 0·090.
9—9·99	(1) 0·113 (2) 0·117 (3) 0·076 (4) 0·075 (5) 0·077.	(1) 0·135 (2) 0·093 (3) 0·088 (4) 0·080 (5) 0·054.
Total number of shells under observation in each season.	61	77

TABLE V

MONTHLY RATES OF GROWTH OF *Trochus niloticus* IN CENTIMETRES.

(*Females.*)

Size-groups (Max. diam. in cms.).	Season—December to April.	Season—May to November.
2—2·99	....	(1) 0·427
3—3·99	(1) 0·402 (2) 0·360 (3) 0·391 (4) 0·325 (5) 0·315 (6) 0·306 (7) 0·310 (8) 0·366 (9) 0·298 (10) 0·283 (11) 0·278.	(1) 0·470 (2) 0·337 (3) 0·281.
4—4·99	(1) 0·400 (2) 0·412 (3) 0·400 (4) 0·320 (5) 0·349 (6) 0·323 (7) 0·331 (8) 0·317 (9) 0·340 (10) 0·297 (11) 0·290 (12) 0·290 (13) 0·276.	(1) 0·420 (2) 0·463 (3) 0·370 (4) 0·390 (5) 0·330 (6) 0·343 (7) 0·317 (8) 0·364 (9) 0·364 (10) 0·257 (11) 0·283 (12) 0·280 (13) 0·254 (14) 0·272.
5—5·99	(1) 0·404 (2) 0·420 (3) 0·340 (4) 0·345 (5) 0·310 (6) 0·308 (7) 0·286 (8) 0·260 (9) 0·264 (10) 0·185.	(1) 0·720 (2) 0·409 (3) 0·328 (4) 0·370 (5) 0·395 (6) 0·372 (7) 0·312 (8) 0·340 (9) 0·320 (10) 0·346 (11) 0·353 (12) 0·356 (13) 0·364 (14) 0·333 (15) 0·326 (16) 0·366 (17) 0·273 (18) 0·297 (19) 0·281 (20) 0·281 (21) 0·290

TABLE V—*concld.*

Size-groups (Max. diam. in cms.).	Season—December to April.	Season—May to November.
6—6·99	(1) 0·306 (2) 0·343 (3) 0·301 (4) 0·306 (5) 0·300 (6) 0·320 (7) 0·306 (8) 0·337 (9) 0·232 (10) 0·280 (11) 0·217 (12) 0·232 (13) 0·266 (14) 0·221 (15) 0·280 (16) 0·162 (17) 0·171.	(1) 0·400 (2) 0·346 (3) 0·330 (4) 0·345 (5) 0·375 (6) 0·324 (7) 0·305 (8) 0·215 (9) 0·240 (10) 0·266 (11) 0·276 (12) 0·219 (13) 0·266 (14) 0·253 (15) 0·237 (16) 0·297.
7—7·99	(1) 0·312 (2) 0·320 (3) 0·220 (4) 0·201 (5) 0·223 (6) 0·216 (7) 0·205 (8) 0·227 (9) 0·172.	(1) 0·272 (2) 0·213 (3) 0·297 (4) 0·203 (5) 0·217 (6) 0·285 (7) 0·277 (8) 0·281 (9) 0·270 (10) 0·252 (11) 0·250 (12) 0·238 (13) 0·152 (14) 0·163 (15) 0·168 (16) 0·166 (17) 0·160 (18) 0·153 (19) 0·181 (20) 0·060.
8—8·99	(1) 0·151 (2) 0·151 (3) 0·126 (4) 0·117 (5) 0·173 (6) 0·173.	(1) 0·232 (2) 0·171 (3) 0·139 (4) 0·170 (5) 0·137 (6) 0·101 (7) 0·114 (8) 0·192 (9) 0·181 (10) 0·133 (11) 0·163 (12) 0·175 (13) 0·162.
9—9·99	(1) 0·155 (2) 0·124 (3) 0·098 (4) 0·086 (5) 0·073.	(1) 0·123 (2) 0·118 (3) 0·077 (4) 0·060.
Total number of shells under observation in each season.	71	92