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ANNUAL REPRODUCTIVE CYCLE OF THE WEDGE CLAM, *DONAX CUNEATUS* LINNAEUS

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THE venerid clam *Venus mercenaria* of the temperate waters is known to have a distinct annual reproductive cycle, gametogenesis taking place during the autumn and winter and spawning between July and September (Loosanoff, 1937). Studies on the reproductive activity of the economically important clams of the family veneridae of the Indian coasts have received some attention. Hornell (1922) has observed that in *Meretrix casta* spawning takes place twice a year, during April-May and September on the east coast. Abraham (1953) and Durve (1964) have found that *M. casta* in the Adyar estuary and Mandapam fish farms spawn several times a year. In the estuarine clam, *Katelsia opima*, Rao (1951) has observed that gametogenesis takes place between April and August and that spawning which commences in December is completed in January. The reproductive periodicity of the clams of the family Donacidae which occur in fair abundance along the Indian coasts has not been studied in detail except for the observations of Nayar (1955) who has stated that *Donax cuneatus* of the Palk Bay spawns between January and April and of Alagarswamy (1967) who very recently reported prolonged spawning from November to June in *D. faba* from Mandapam coast. The annual reproductive cycle of *D. cuneatus* of the Madras coast has been studied in the present work based on the seasonal gonadal changes of the adult clams.

MATERIAL AND METHODS

In the intertidal region *D. cuneatus* occurs lying buried in sand a few inches deep with the siphons opening flush with sandy surface of the beach where the surf breaks. Random samples, each of 40 to 50 adult clams were collected every month from Triplicane beach from December, 1962 to December, 1964. The gonadal condition was studied by examining microscopically smears of fresh gonads and also the microtome sections of gonad tissue fixed in picro-formal or alcoholic Bouin's fluid. Sections were cut 8μ thick and stained either in Heidenhan's haematoxylin or Meyer's acid haemalum and counter-stained with eosin.

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OBSERVATIONS

Seasonal Gonadal Changes

In December, 1962 when the observations commenced the gonadal follicles in males of *D. cuneatus* were full with ripe spermatozoa and the interfollicular tissue occupied very little space (Pl. I, Fig. 1). In female clams the ovarian follicles contained some ripe ova free in the lumina and others still attached to the germinal epithelium lining the follicular walls. Most of the ova were in readiness to be discharged. As some of the follicles contained lumina without ova in the middle region it appeared that spawning has already started and the ova to some extent have been discharged during the month (Pl. I, Fig. 2).

In January, 1963 the gonads of some of the male clams showed partially spawned condition and of others in fairly advanced stage of spawning. The follicular walls appeared shrunken and the lumina showed varying degrees of emptiness. A similar condition was noticed in the ovarian follicles in the females. The occurrence of gonads in this condition persisted till June, 1963 indicating a prolonged spawning period extending to about six months. Pl. I, Fig. 3 shows gonad of a female clam after spawning with a few residual ova left in the follicles, which have shrunk much and the interfollicular tissue has developed to a large extent.

In July the gonads of both sexes showed shrunken follicles due to resorption of follicular tissue ; the interfollicular tissue was well-developed and conspicuous and the residual ova were in the process of being engulfed by the phagocytes (Pl. I, Fig. 4). In August most of the clams did not show any marked differences from those observed in the previous month, but in some the sexes were indistinguishable. The residual reproductive elements having been completely absorbed, the follicles have immensely shrunk and the lining germinal epithelium was noticed to be in an inactive phase, without proliferating the primordial germ cells (Pl. I, Fig. 5).

In September in the gonads of both sexes gametogenesis has commenced. In the testes the reproductive follicles contained a large number of early stages of gametogenesis viz. spermatogonia, spermatocytes and also very few fully developed spermatozoa (Pl. II, Fig. 6) and in the ovaries a large number of oocytes (Pl. II, Fig. 7).

During October and November the clams were in maturing stages, the gonads being in a very active phase of gametogenesis, with rapid increase in size of follicles which in testes contained male reproductive elements in all stages of development including fully formed spermatozoa (Pl. II, Fig. 8) and in ovaries developing oocytes and ova of varying sizes and numbers (Pl. II, Fig. 9).

In December, 1963 the gonads of both sexes were ripe. Between January and June of 1964 the gonads were again in partially or fully spawned condition ; by July and August the residual reproductive elements were all absorbed ; by September onwards gametogenesis commenced and the gonads were fully ripe by December, 1964 as in the previous year. It may thus be seen from the foregoing account that *Donax cuneatus* of Madras coast has a distinct annual reproductive cycle with prolonged spawning extending from December-January to June.

Observations on Environmental Factors

The salinity values were estimated and water temperatures recorded for the period of observations on the gonadal changes in the clams. The monthly mean values are shown below in Table I and Fig. 1.

TABLE I

Seasonal variations in temperature and salinity of inshore waters of Madras Coast

1962-'63

	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Apr.
Temperature °C.	26·4	27·3	28·7	29·4	30·8	31·5	30·4	28·9	28·9
Salinity ‰	25·84	28·52	30·49	31·42	34·37	35·86	35·62	34·38	35·39

1963-'64

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June
Temperature °C.	27·3	27·4	27·6	26·3	27·3	28·8	29·4	30·3	31·8	30·7
Salinity ‰	34·76	28·73	28·42	26·36	29·85	31·46	32·75	36·29	35·66	35·54

Mean : Temp. 28·9 ° C. and Salinity 32.19 ‰.

The water temperature varied over a limited range. As shown above, the lowest value was 26·3°C. in December, 1963 and the highest 31·8°C. in May, 1964. The values show an increase from January to June after which there is a decline in the next six months. The lowest salinity value was noted in December, 1962 (25·84‰) and the highest value in April, 1964 (36·29‰). From January the values were on the increase upto May ; thereafter they remained more or less steady at fairly high level till September. In October there was a sharp fall and in the following three months further decrease in the mean values. It may be noted that the spawning period of *D. cuneatus* coincides with the period when both temperature and the salinity values were observed high. This coincidence may be incidental. The ranges of variation in both the salinity and the temperature values being small it is difficult to say whether the prevalence of relatively high values can be considered to induce spawning during this period. It may also be noted that active gametogenesis took place in both sexes at a period in the year when temperature and salinity values were low.

GENERAL CONSIDERATIONS

The observations made in the course of the present work indicate that *Donax cuneatus* of the Madras coast has a distinct annual reproductive cycle in which the gametogenetic activity does not commence soon after spawning as is the case with some of the venerid clams, viz. *Venus mercenaria* (Loosanoff, 1937) and *Meretrix casta* (Durve, 1964) but begins after a lapse of about two months following spawning. However, as in most clams the discharge of gametes in *D. cuneatus* takes place

intermittently over a long period. The spawning season in this species on Madras coast is longer than in the same species occurring in Palk Bay where it is reported to extend from January to April (Nayar, 1955). A similar case of very

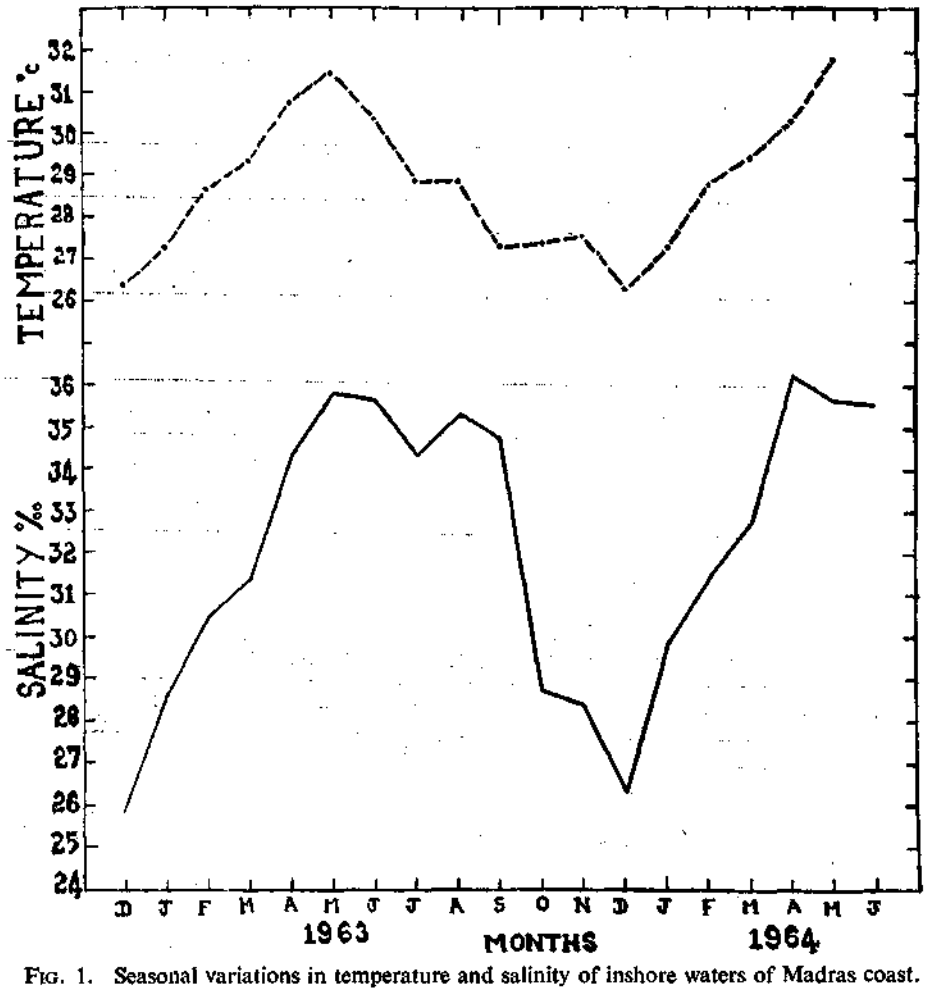

FIG. 1. Seasonal variations in temperature and salinity of inshore waters of Madras coast.

prolonged breeding period has been known to occur in the razor shell *Solen kempi* which spawns from October to March on the north west coast of India. (Rao, *et. al*, 1962) and in the wedge clam *Donax faba*, which spawns from November to June (Alagarswamy, 1967).

In the nature of their reproductive cycles, even in the same species, clams of one locality are known to differ from those of a different locality. Thus *Mya arenaria* of New Haven (Coe and Turner, 1938) and of the Gulf Maine (Ropes and Stickney, after Shaw 1965) have a single annual reproductive cycle as contrasted with clams of the same species from Wickford Harbour, Narragansett Bay (Landers, 1954) and those of Solomon Islands on the western shore of Chesapeake Bay (Rogers,

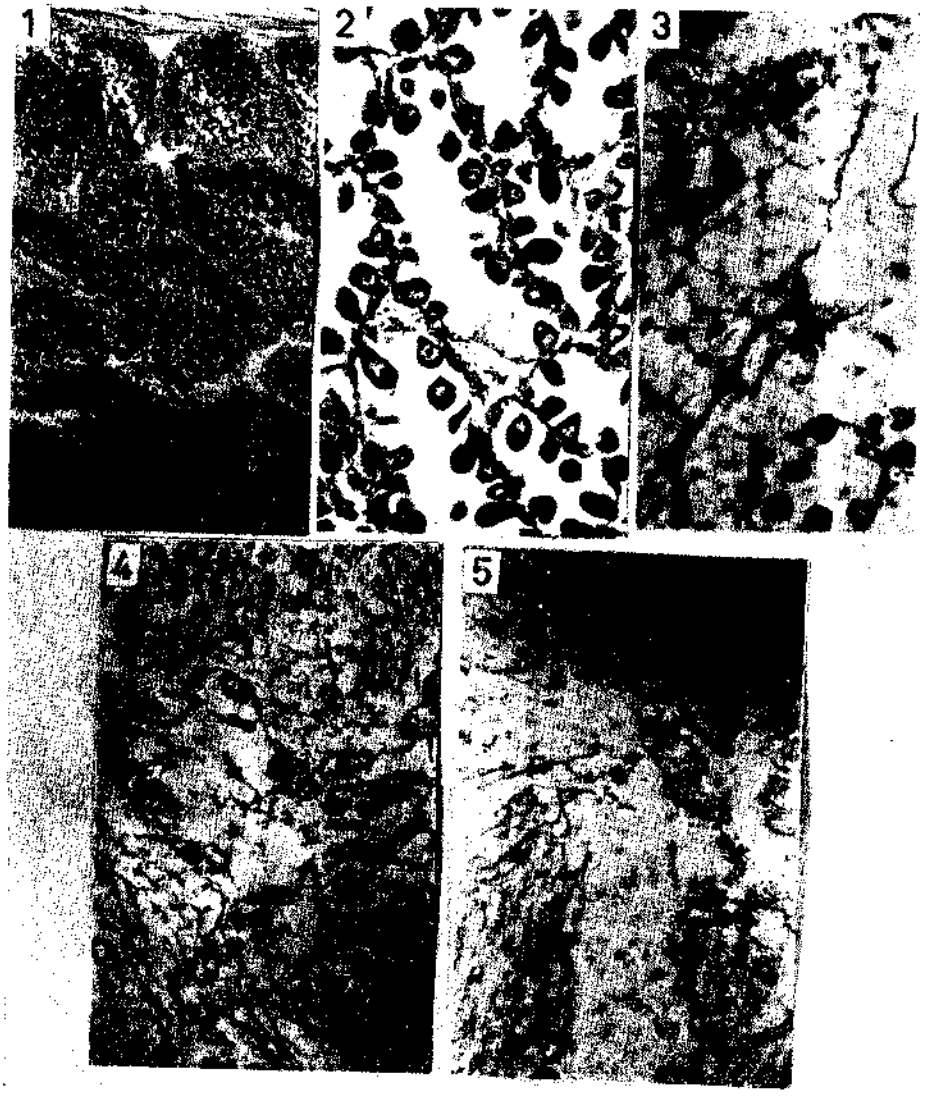

PLATE I

FIG. 1. Testis of *Donax cuneatus* with ripe spermatozoa in follicles.
FIG. 2. Ovary containing ripe ova along inner walls of follicles.
FIG. 3. Partially spawned ovary.
FIG. 4. Spent ovary with highly shrunken follicles.
FIG. 5. Gonads in sexually indeterminate phase.

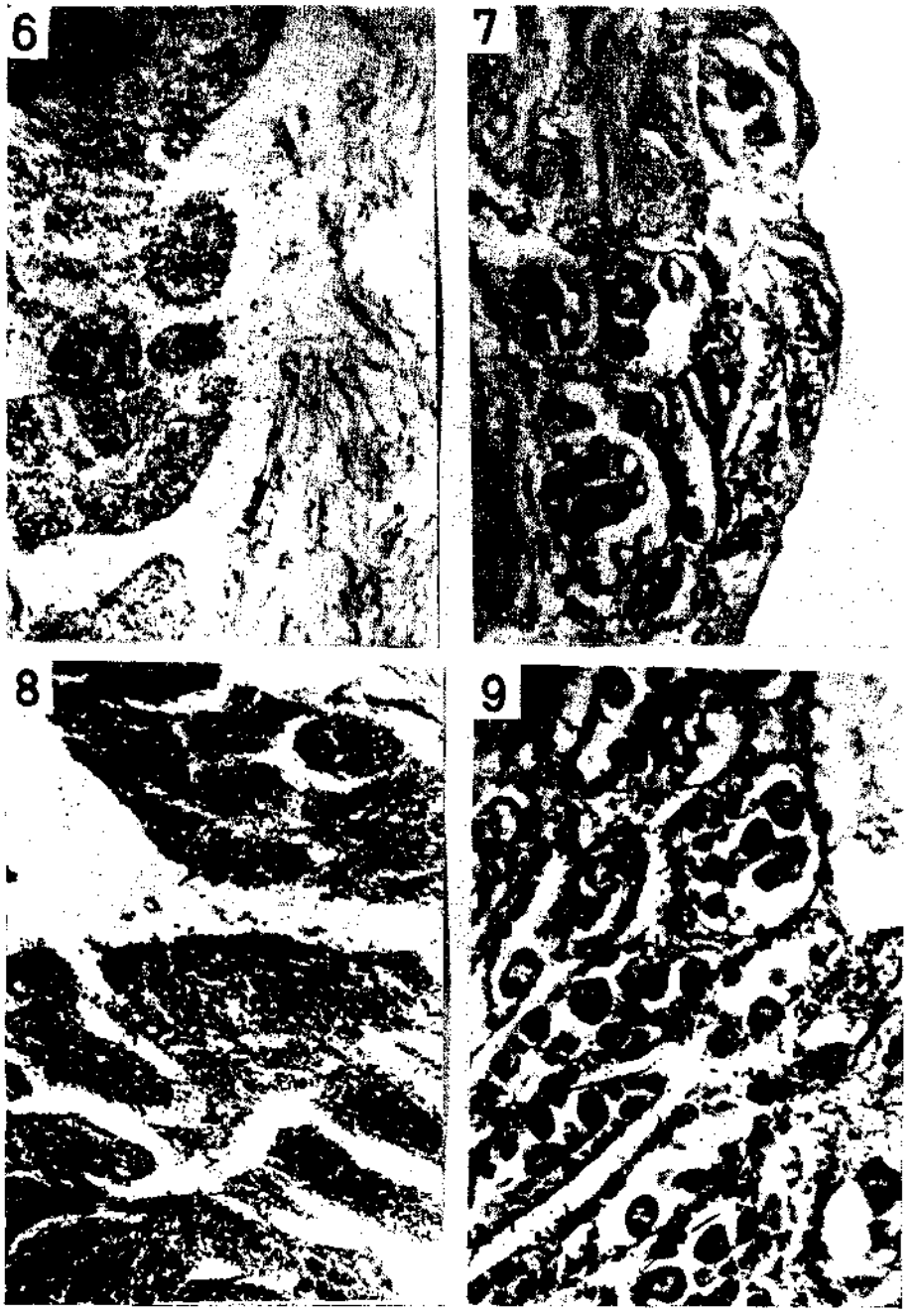

PLATE II

FIG. 6. Immature testis showing beginning of spermatogenetic activity.
FIG. 7. Immature ovary showing development of oogonia and oocytes.
FIG. 8. Maturing testis showing active spermatogenesis.
FIG. 9. Maturing ovary with rapidly developing oocytes.

1959) which have two reproductive cycles in a year. The studies of Pfitzemeyer (1962) on the clam larval counts and the seasonal gonadal changes in *Mya arenaria* also show that there are two reproductive cycles a year unlike the more northern populations. *D. cuneatus* of the Madras coast and those from Palk Bay (Nayar, 1955) have only one reproductive cycle, although in the former locality the breeding period is relatively much longer. The causes behind the differences in the breeding behaviour of clams from different localities may be sought in the differences in the environmental factors but unfortunately not much is known about them.

Although the ranges in the monthly mean temperature and salinity values are not markedly high, there appear to be distinct seasonal trends in their fluctuations having a bearing on the breeding behaviour of *D. cuneatus* as stated earlier. In temperate regions, that an optimum warm temperature is required for spawning in clams is well known (Loosanoff, 1937; Loosanoff and Davis, 1950). In tropical regions also a slight increase in temperature is known to correspond with the period of breeding ; the data of Nayar (1955) show that in *D. cuneatus* spawning takes place when the water temperature is on the ascent.

Abraham (1953) has shown that *Meretrix casta* spawns in Adyar backwaters in low salinity conditions. Rao (1951) has observed that in *Katelysia opima* spawning takes place when salinity increases when the sand bar at Adyar river mouth opens and the sea water enters the estuary, which the species inhabits. He has suggested that rise in salinity in the environment induces spawning in that species. The data on the seasonal variations in salinity and spawning of *D. cuneatus* show a relationship similar to that found in *Katelysia*.

Summary

A study of the seasonal gonadal changes in *Donax cuneatus* of the Madras coast has shown that the species has a single reproductive cycle during the course of a year. Gametogenesis takes place between September and December ; spawning is initiated about December-January and it extends upto June. Active gametogenesis takes place in both sexes at a period when the temperature and salinity are low and spawning when the temperature and salinity are high.

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