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GONADS IN LARVAL ACRANIATES

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ABSTRACT

For the first time since 1905 gonads in larval acraniates, both male and female, are reported and pictured. Location is off the S. W. coast of India. The paper discusses their possible origin *vis-a-vis* Indian Ocean water movements.

INTRODUCTION

A PREVIOUS paper (Wickstead, 1975) concluded with the following remarks: "It is interesting to note that in the view of Bone (1960)'.....the Acrania are free-swimming neotenously produced adult forms.....'. Thus it is, zoologically speaking, intriguing to speculate on a neotenously produced adult form which can produce a larva possibly with the capability of paedogenesis." The discovery now recorded of gonads containing reasonably well advanced oocytes and spermatids gives some strength to this speculation.

Gonads were first reported in amphioxides larvae nearly three quarters of a century ago and have not been reported since; hence there was some doubt with regard to the validity of this observation. Goldschmidt (1905) reported 27 amphioxides from the 'Valdivia' Expedition, of which three specimens showed developing gonads. One was *Amphioxides valdiviae*, another *A. pelagicus* and the third I take to be *A. pelagicus* also. Goldschmidt's (1905) conclusions concerning the gonads were logical, but not correct; he concluded ".....they are mainly of interest because they exclude the possibility that Amphioxides could be the larvae of an unknown branchiostomid." As more specimens became available it soon became evident that amphioxides was indeed a larval form, *A. pelagicus* being the larva of *Asymmetron lucayanum* Andrews and *A. valdiviae* probably the larvae of *Asymmetron maldivense* (Cooper) (Wickstead, 1979); *Amphioxides stenurus* is a synonym of *A. pelagicus* (Wickstead, 1964 a).

GEOGRAPHICAL LOCATION AND WATER MOVEMENTS

Although 189 specimens are considered here, 188 *Amphioxides pelagicus* (Günther) and 1 *Amphioxides valdiviae* Goldschmidt, their distribution both geographically and within the cruise programmes of the International Indian Ocean Expedition (IIOE), is much more limited than the numbers suggest. Virtually all the specimens were taken on two cruises (104 & 106) of the Indian R. V. VARUNA. 119 were taken between November 4-6, 1963 on Cruise 104 at Stations 2006 (3 specimens), 2007 (6), 2008 (1), 2009 (1), 2010 (29), 2011 (3), 2012 (7), 2013 (5), 2013 A (32) and2014 (32) while 59 were taken between December 9–10, 1963, on Cruise 106 at Stations 2037 (3 specimens), 2038 (30), 2039 (1), 2040 (5), 2041 (19) and 2041 A (1).

Of the remainder, eight specimens were taken by R.V. 'KISTNA', all on Cruise 25, Station 645 (1 specimen), March 23, 1965, Station 663 (1 specimen) March 26,

1965, and Station 664 (6 specimens) March 27, 1965; and two were taken by R. V. 'DISCOVERY', both on Cruise 3, Station 5380 (1 specimen) May 14, 1964 and Station 5386 (1 specimen) May 23, 1964.

For details of these stations reference should be made to the International Indian Ocean Expedition, Handbook to the International Zooplankton Collections, Volume 1, Station List; Table 1 shows the latitude and longitude. It can be noted here that all the stations were near the west or southwest coast of India with the exception of one of the 'Discovery' stations, 5386, which was in the middle of the Arabian Sea. The single *A. valdiviae* was at 'Discovery' Station 5412 June 2, 1964, at 02°02′ N. 56°03′ E.

TABLE 1. *Station positions*

Station No.	Latitude	Longitude	Station No.	Latitude	Longitude
Va 2006	09°00′N	75°58′E	Va 2038	14°58′N	72°32′E
Va 2007	09°00′N	75°20′E	Va 2039	15°00′N	73°05′E
Va 2008	09°04′N	74°40′E	Va 2040	15°00′N	73°16′E
Va 2009	09°04′N	74°00′E	Va 2041	15°00′N	73°28′E
Va 2010	09°03′N	74°20′E	Ki 645	17°24′N	71°22′E
Va 2011	09°00′N	72°40′E	Ki 663	12°15′N	73°25′E
Va 2012	09°00′N	72°00′E	Ki 664	10°00′N	74°30′E
Va 2013	09°05′N	71°20′E	Di 5380	10°03′N	70°37′E
Va 2014	09°10′N	70°40′E	Di 5386	12°02′N	62°59′E
Va 2037	15°01′N	72°00′E			

Two questions which spring to mind are (1) from where did the larvae originate and (2) how old were the larvae when caught.

From the distribution of the species it would appear that the centre of distribution of the Acrania as a group is the Indo-Pacific. The adults of both *A. pelagicus* and *A. valdiviae* can be found in both the Indian Ocean and the Southwest Pacific. The larvae under discussion could thus, theoretically, have been caught tens, hundreds or thousands of miles from the parent population.

An acraniate has a planktonic larval phase varying, normally, between one and a half to four months (Wickstead, 1975) or even longer (Webb, 1975). An amphioxides larva however is considered to be a 'giant larva' developing some special adaptations for a prolonged pelagic existence, and living for possibly a year or more in the plankton (Wickstead, 1964 b). Since the larvae under discussion show no signs of metamorphosis and have developed incipient gonads, it is not unreasonable to assess their age as being six months, with some possibility of it being > one year.

How far could such an animal travel in six months or a year and, extrapolating backwards, what could be the point of origin? Some estimates can be obtained from Satyanarayana Rao (1963), who quotes some drift per day figures for drift bottles. Figures vary between eight and 30 miles a day; in six months this would amount to between about 1,450 and 5,500 miles.

In view of the large numbers of variables and imponderables, with the limited data available it would be fruitless to spend much time on this problem. An overall consideration would give the odds somewhat in favour of the original population

being located at one of the island groups of the Indian Ocean; but there is a distinct possibility that it could be located in the Indonesian Archipelago, or even further east.

It has been noted previously (Wickstead, 1961) that there is a year-round current westwards through the Sunda Strait into the Indian Ocean and a year-round current flowing north-west through the Malacca Strait into the Indian Ocean. Acraniate larvae could be carried through either, or both, of these Straits into the South Equatorial Current across to Africa and, during the Southeast Monsoon, be carried north along the East African Coast into the Arabian Sea, following the clockwise movement, thus finishing up off the west or southwest coast of India at the finish of the Southeast Monsoon, *i.e.* November or early December. An earlier work (Wickstead, 1964 a) commented on the similarities between Sunda Shelf and East African zooplankton. Examination of hydrographic charts and data (U.S. Navy, 1958, and U.K., H.M.S.O., 1936, charts; Newell, 1957) will show that a current pathway does exist between the two areas. According to the drift bottle data of Satyanarayana Rao, it would be possible for an acraniate larva to enter the Indian Ocean *via* the Malacca Strait, and be transported in a current directly westwards to southwest India. According to the drift bottle data, this current can register a net movement in a westerly direction of some 200 miles a week. Therefore, given the reasonable assumption that amphioxides larvae can survive in the plankton for six months, possibly one year, then there is a good chance of the Indian Ocean population of *A. lucayanum* and *A. maldivense*, the respective parents of *A. pelagicum* and *A. valdiviae*, being strengthened by recruitment from Indonesian Archipelago populations.

A particular point of interest concerns *A. valdiviae*. The presumed adult, *A. maldivense*, has been recorded outside the Indo-Pacific area; but Goldschmidt (1905) recorded an *A. valdiviae* from near the Canary Islands, at 24° 43′N–17° 1′W. An explanation for this lies in the drift bottle data of Satyanarayana Rao. A drift bottle released very close to Discovery Stn. 5412, at which the *A. valdiviae* with gonads was found, was recovered on the west coast of Africa, near 6°N, having drifted nearly 6,000 miles in about 400 days. This indicated a net movement of about 15 miles a day.

Webb (1975) has stressed the potential value of amphioxus and the larval forms as indicators of current flow and water masses. Clearly this could have important application in the Indo-Pacific Regions.

Discussion

From the International Indian Ocean Expedition 1,001 specimens of *A. pelagicus* and 584 specimens of *A. valdiviae* have been examined. Of these, 188 specimens of *A. pelagicus* and one specimen of *A. valdiviae* were noted as having, possibly, developing gonads. There is some uncertainty, due to the generally poor state of fixation and preservation; in many cases there were varying degrees of autolysis.

Previously (Wickstead, 1975) the appearance of the developing gonads has been described as '.. lappet-like extensions of the myotomes.....'. In numerous specimens, due to poor fixation and/or varying degrees of autolysis, just this did happen; there were extrusions of the myotomes at the lower end, giving the appearance of a row of developing gonads. Therefore it cannot be stated emphatically that all 189 specimens had developing gonads; sectioning would be necessary to establish without

doubt the presence of gonads in many of the specimens. However, it can be stated with confidence that 50% had developing gonads. Plate I A shows the appearance of an *A. pelagicus* having definitely developing gonads, Plate I B showing developing female gonads, Plate I C developing male. These specimens have been cleared in benzyl alcohol and lightly stained with Light Green.

Various states of gonad development are present, the most developed appearing to be at about the same stage as in Goldschmidt's specimens. Goldschmidt noted (1905); "One sees its position in the gonocoel and one notes that the gonad contains all stages of development up to spermatids, *i.e.* almost mature, and represents a state Zarnik has described for an Amphioxus of 28 mm length from Brittany."

Both males (Plate II A, B) and females (Plate II C, D) were present. Unfortunately, due to the poor fixation and preservation, observations on fine detail are not very satisfactory. However, the developing spermatocytes and oöcytes can be seen clearly.

Do functional germ cells ever develop in these larvae? There is no evidence to suggest that this is the case; but with the larval gonads containing germ cells at a fairly advanced stage of development, the possibility cannot be ruled out entirely. Although amphioxides larvae with developing gonads are not very common, the possibility does exist for some future experimental work to induce the gonads to develop to maturity.

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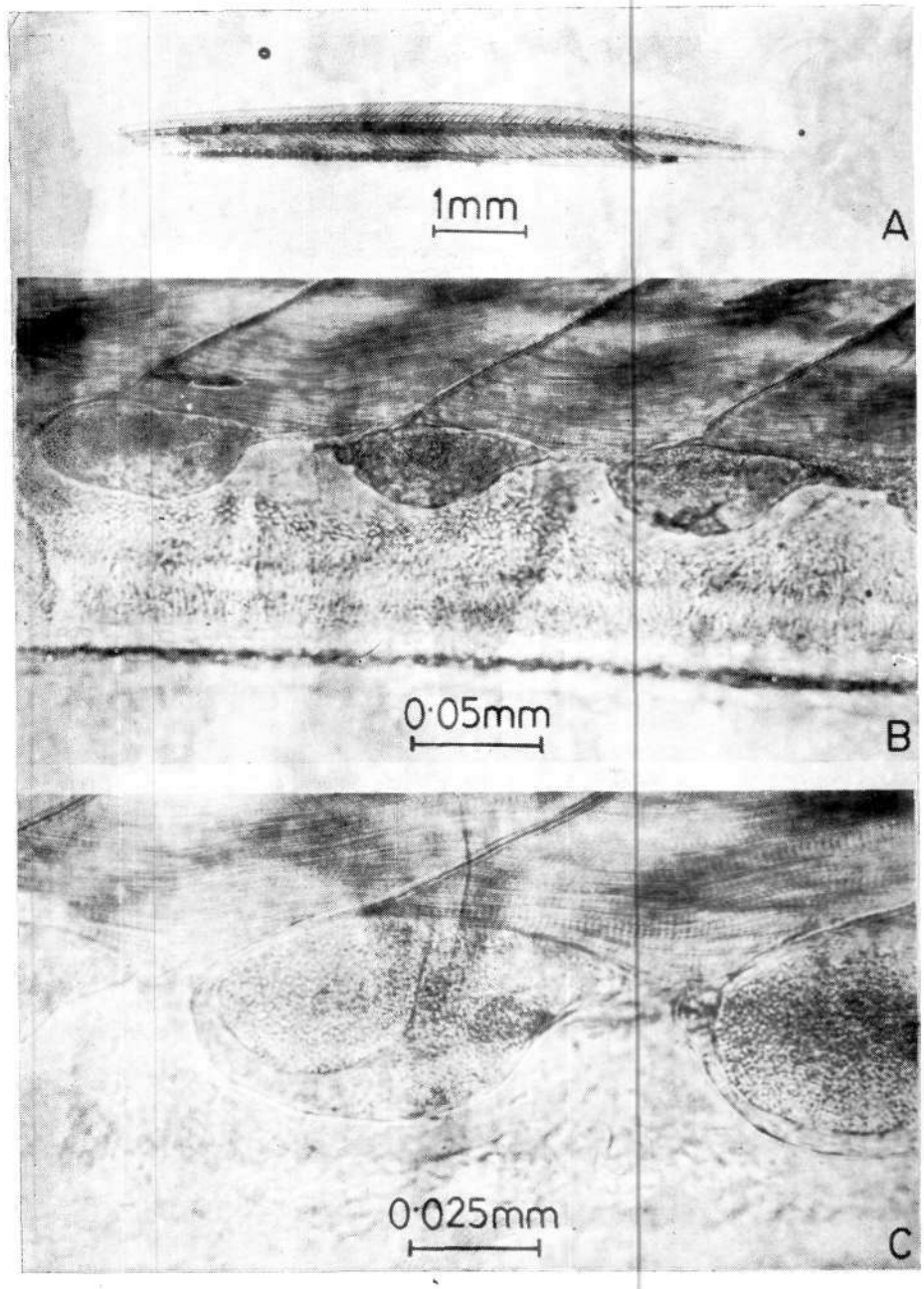

PLATE I. *Amphioxides pelagicus* : A. Whole animal showing position of developing gonads, B and C. higher magnification showing appearance of developing gonads - B. female and C. male.

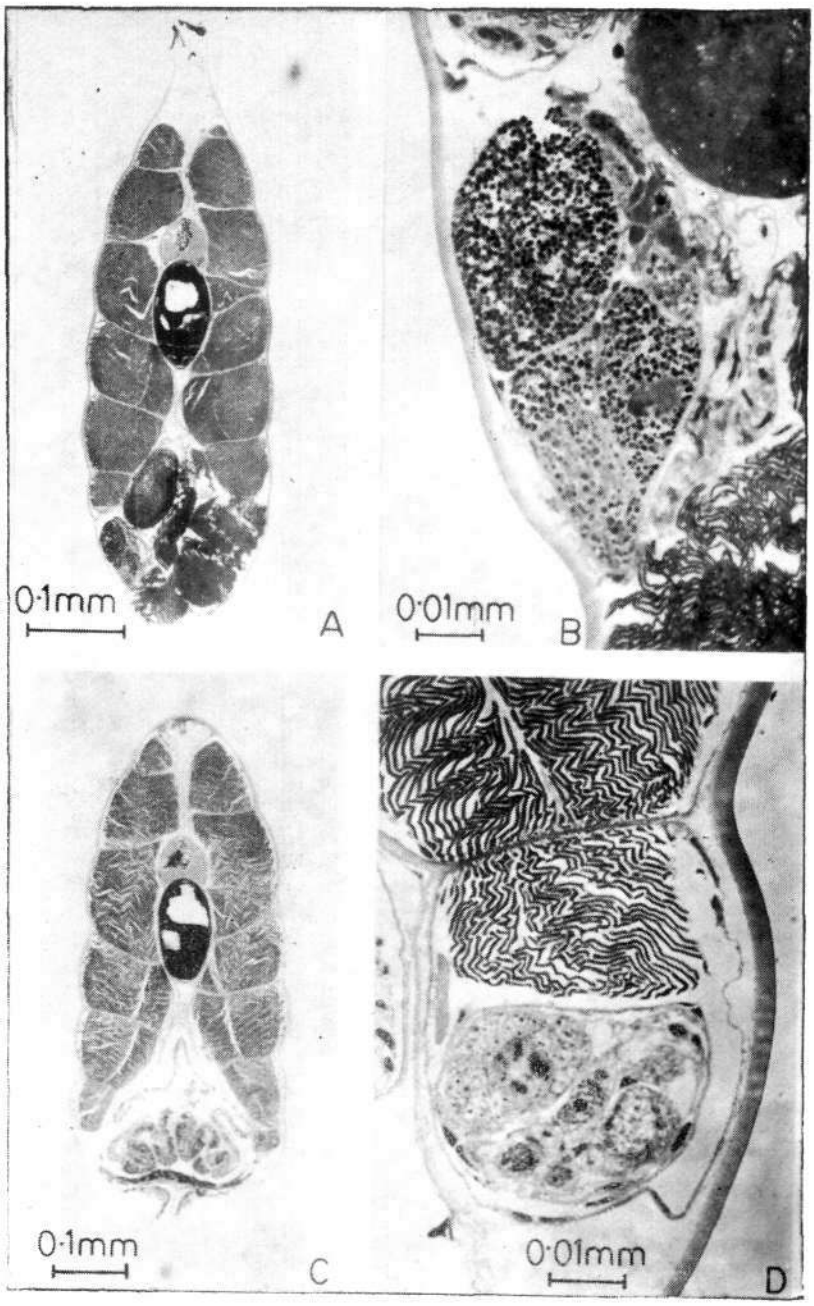

PLATE II. Transverse sections of *Amphioxides pelagicus* : A. T.S showing position of male developing gonad, B. enlargement of developing male gonad, C. T.S showing position of developing female gonad and D. enlargement of developing female gonad.

NOTE : As in the adult *Asymmetron*, unilateral gonads are developed along the right side only.