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Reverse polarity in *Nauclea orientalis*, L. (*Sarcocephalus cordatus*, Miq.)

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ABSTRACT

Embryo sac development conforms to Polygonum type. Starch grains are noticed in the embryo sac right from the megaspore mother cell stage. Twin tetrads one with a chalazal functional megaspore and another with a micropylar functional megaspore have been noticed in some ovules. While 75% of the embryo sacs have normal polarity, in 20% of the ovules reverse polarity has been noticed. In the remaining 5% of the ovules, 'bipolarity' has been observed. Reverse polarity in relation to double archegoniate theory has been discussed.

1. INTRODUCTION

THE embryo sac of angiosperms is generally characterised by the remarkable polarity it exhibits. The egg apparatus is organised at the micropylar end while the antipodals are formed at the chalazal end.

However there are instances of reverse polarity. Some of the earlier reports on reverse or inverted polarity include those of *Allium nigrum*,[1] *Eriodendron aufruticosum*,[2] *Rudbekia bicolor*,[3] *Wodferdia floribunda*[4] and *Crinum asiaticum*,[5] etc.

So far, there have not been any reports of reverse polarity in *Rubiaceae*. The present paper deals with the occurrence of reverse polarity in *Naucleae orientalis*, L., a tree belonging to the tribe *Naucleae* of the family *Rubiaceae*.

2. MATERIALS AND METHODS

Flower heads of *Nauclea orientalis*, L. growing in Lalbagh gardens (Bangalore) were collected and fixed in F.A.A. Serial paraffin sections were cut at 8–10 μ, stained with Heidenhein's iron alum haematoxylin and counter stained with erythrosin.

3. Observations

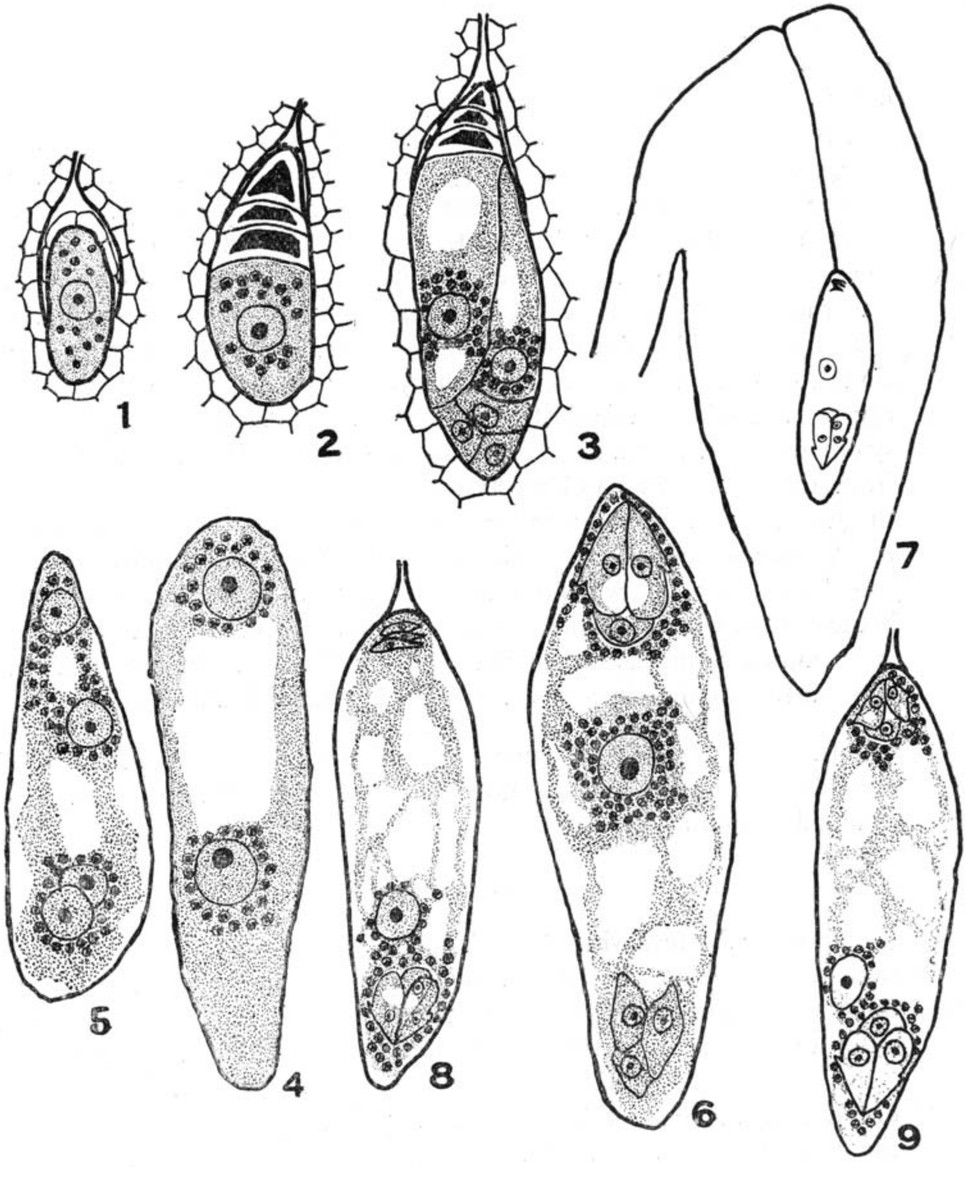
The ovary is inferior with many pendulous ovules. The ovules are unitegmic and tenuinucellate. A single sypodermal archesporial cell differentiates in the nucellus and directly functions as the megaspore mother cell (figure 1). The megaspore mother cell undergoes reduction division and produces a linear tetrad of megaspores, of which the chalazal one is functional (figure 2). In about 5% of the ovules twin tetrads have been noticed. In one instance the ovule had juxtaposed twin tetrads, one linear and the other inverted 'T'shaped. In the linear tetrad the chalazal megaspore was functional and in the 'T'shaped tetrad the micropylar megaspore was functional (figure 3). In no case, however, twin embryo sacs have been noticed. The functional megaspore undergoes three successive divisions to form an eight nucleate embryo sac of the polygonum type. The egg apparatus is organised at the micropylar end and consists of two beaked synergids and a median egg (figures 4 to 6). Starch grains are found right from the megaspore mother cell up to the organised embryo sac. While the normal polarity characterises about 75% of the ovules, in 20% of the ovules reverse polarity is noticed In these ovules the micropylar region consists of three cells which do not show any vacuolation and bear no resemblance to the egg apparatus. In the chalazal region a typical egg apparatus is organised with the usual characteristic features. In the chalazal egg apparatus also the synergids are beaked (figures 7 and 8).

In about 5% of the ovules, "*Bipolarity*" (*i.e.*, organisation of egg apparatus at either ends) is noticed. Both egg apparatuses have beaked synergids (figure 9).

4. Discussion

In critically reviewing Porsch's theory on the morphology of the embryo sacs Swamy[5] opines that the cases of inverted polarity strongly support the double archegoniate theory and hence it should be accepted that the micropylar and chalazal quartrets represent an archegonium each. He states that "though the instances of inverted polarity are sporadic, they are well distributed and cannot be without any significance". He considers that the cases of reverse polarity are instances where the potential of the micropylar archegonium is suppressed. The non-fertilization of the chalazal egg apparatus[5] is because of the distance involved between the point of entry of the pollen tube and the chalazal egg apparatus.

If one accepts Porsch's theory, then it means that the vegetative tissue is totally eliminated from the embryo sac since the micropylar and the chalazal quartrets represent an archegonium each. But it is rather difficult to accept



Figures 1–9. 1. Megaspore mother cell, × 2,000. 2. Linear tetrad of megaspores, × 2,000. 3. Twin tetrads, × 2,000. 4–6. Stages in the development of the embryo sac, × 2,000. 7. Section of the ovule showing embryo sac with inverted polarity, × 2,000. 8. Same enlarged, × 2,000. 9. Embryo sac showing bipolarity, × 2,000.

this assumption. There is no doubt that one of the characteristic features of heterosporous vascular plants (not excluding Angiosperms) is the progressive degeneration of the gametophytes. Between the male and female gametophytes, degeneration, however, is extreme in the former as its role is limited. A male gametophyte is needed only up to fertilisation. Whereas in the female gametophyte degeneration cannot reach the level seen in ihe male gametophyte for obvious reasons. The female gametophyte has a greater responsibility than the male, in that, it has to protect and nourish the embryo. That is why even in Angiosperms the female gametophyte is not reduced to the extent of the male gametophyte. In Angiosperms maximum reduction is achieved in the male gametophyte in that, it has only a vegetative cell and two gametes. Accepting that in the female gametophyte reduction is not to the extent seen in the male gametophyte, if according to Porsch's theory the embryo sacs were to contain two archegonia, what has happened to the vegetative cells ? Surely they could not have been totally eliminated particularly when they still find a place in the male gametophyte. According to double archegoniate theory there are no vegetative cells. Indeed this is very difficult to comprehend.

Coming to cases of inverted polarity supporting the double archegoniate theory, it may be said that the stress and strain of certain physiological conditions may induce the reverse polarity. Though they are well distributed, as conceded by Swamy,[5] they are sporadic. Against a vast majority of normal embryo sacs ovules with reverse polarity are really freaks. Freaks being what they are, are unsuitable to decide a major morphological problem.

If the chalazal egg apparatus were to be really functional, there should have been instances of their fertilisation and subsequent embryo formation. In spite of innumerable observations of reverse polarity there is no instance of their normal functioning. Though there are rare instances of fertilisation as in *Aster*[6] and *Ulmus*,[7] as stated by Swamy,[5] in these plants "Fertilisation of the antipodal egg has been shown or assumed ". Even granting that in these two plants there is fertilisation there is no record of their further development. The reason given by Swamy that the distance between the point of entry of the pollen tube and antipodal egg apparatus makes fertilisation difficult does not seem to be very logical. For, in chalazogamy the pollen tube even though pierces the ovule near the chalazar, grows up to the micropyle as it finds no egg apparatus in the chalazal region. Similarly in reverse polarity also if chalazal egg apparatus were to be really a functional one, the pollen tube would have definitely grown downwards and reached the egg apparatus. But it never does so, indicating that the chalazal egg apparatus just has a morphological semblance of the egg apparatus.

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