situ towards the ground (figure 1). However, their growth was found to be limited and they were not found to resemble prop roots of *Rhizophora* species.

In both cases, it is safe to conclude that the aerial roots are of no mechanical advantage to the trees, but probably assist in increasing their total respiratory surface as observed by the presence of lenticels around the roots, and their anatomical similarity to pneumatophores or prop roots.

B. cylindrica is recorded all around the east coast and also in the Andaman and Nicobar islands[1,2]. Along the west coast, its presence is reported in the Bassien creek near Naigaon of Thana taluk of the Konkan coast, the Kali nadi banks near Karwar of the Karnataka coast, and near Quilon of the Malabar coast of Kerala. In the present field survey, its presence was noticed along the muddy flats of Baindur hole near Paduvari of the Coondapur taluk in the Dakshina Kannada district of the Karnataka coast (figure 3). This new locality record of its presence in the intertidal regions of estuarine rivers of the Karnataka indicates that this species is far and sporadically spread along the west coast of India.

C. decandra is common along the estuarine rivers of the Karnataka coast. It forms pure stands, especially towards the landward edges of tidal banks. *Ceriops*, like other mangrove species, is viviparous and possesses a fruit very similar to *Rhizophora* but with 5 or 6 calyx lobes instead of 4, while the hypocotyl is distinctly 5 angled when approaching maturity and almost black instead of green. In a few plants growing along the muddy estuarine banks of the Alvekodi at Shirror hole in the Coondapur taluk in the Dakshina Kannada district of the Karnataka coast the authors however, observed a few instance of two hypocotyls from the same fruit (figure 2).

Instances of the occurrence of two or more hypocotyls from a single fruit have been reported in many taxa of eumangroves[3-9]. This feature for *Ceriops decandra* is the first record for the Karnataka part of the Malabar coast. The reversed pear-shaped relatively small fruit with 5 small persistent calyx lobes bearing two hypocotyls of unequal size and length was observed on a few shrubs growing on the rather muddy flat areas around Alvekodi, which are flooded by the normal high tides. This multiple viviparity as reported in a few mangrove taxa is actually caused by the development of seeds of adjacent locules of a single ovary. It is tempting to speculate that multiple viviparity may correlate quite well with the saline conditions of the environment and this can be considered as part of a syndrome of characters connected with adaptations to overcome environmental hazards.

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GRANIFEROUS TRACHEARY ELEMENTS IN THE HAUSTORIUM OF *SCLEROPYRUM WALLICHIANUM* ARN. (SANTALACEAE)

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A MAJORITY of the taxa of Santalaceae are root hemi-parasites attacking a variety of host plants by means of haustoria. The demonstration of a unique type of tracheary elements with granules in their lumen in the haustoria of some Santalaceous taxa[1-3] and their enigmatic role in haustorial function has led to the search for similar structures in the remaining taxa of the family. In this paper, we record the presence of graniferous tracheary elements in the haustorium of *Scleropyrum wallichianum* Arn., a root hemiparasite of the Santalaceae as earlier studies on this taxon have failed to document them[4].

The haustoria of *S. wallichianum*, measuring up to 12 mm in diameter and 9 mm in height, were collected from Petdoor, Subrahmanya and Hulical ghats in Karnataka, on the roots of *Hopea ponga* (Dennst.) Mabberly (figure 1A), *H. racophloea* Dyer, *Strychnos nux-vomica* Linn., *Zizyphus oenoplia* Mill., and *Eupatorium adenophorum* Spreng. Haustoria were fixed separately in FAA and in Navaschin's solution and processed for microtomy with tertiary butanol. Paraffin embedded haustoria were sectioned at 8–15 μm with a rotary microtome. Safranin-aniline blue staining combination was employed for anatomical observations. For histochemical studies, sections were stained with ninhydrin-Schiff's reagent and mercuric chloride-bromophenol blue for proteins and periodic acid-Schiff's reagent (PAS) for carbohydrates[5-6].

The organization of the haustorium in the present taxon is typical of a Santalaceous root hemi-parasite[4,7-9]. In a longitudinal section of the haustorium, a central parenchymatous region is found flanked on either side by the xylem tissue (figure 1B). There is an apparent interruption in the xylem continuity between the parent root and the vascular elements of the haustorium. Host root and the haustorial body are usually held together by a single pair of clasping folds. Collapsed layers with their branches extending into the endophyte are present in the cortical region. The endophyte remains in contact with host xylem cylinder over a large surface area and is saddle-shaped. Xylem of the haustorium is in direct contact with that of the host root.

Maceration of haustoria reveals the presence of a large number of perforated tracheary elements. The perforations are oriented transversely or sometimes obliquely. They are occasionally found on the lateral walls as well. Perforations are simple and more or less circular in outline. The secondary wall material is deposited in a scalariform or reticulate fashion with simple or bordered pits. The vessel members are much shorter (21–90 μm) and are of various shapes (figures 1 C–E). The presence of a large proportion of perforate elements in *S. wallichianum* is in accordance with the studies on other Santalaceae[4,9] and the opinion of Kuijt[8], but is in contrast to the observation of a greater number of imperforate elements in *Exocarpus bidwillii* and *Mida salicifolia*[3].

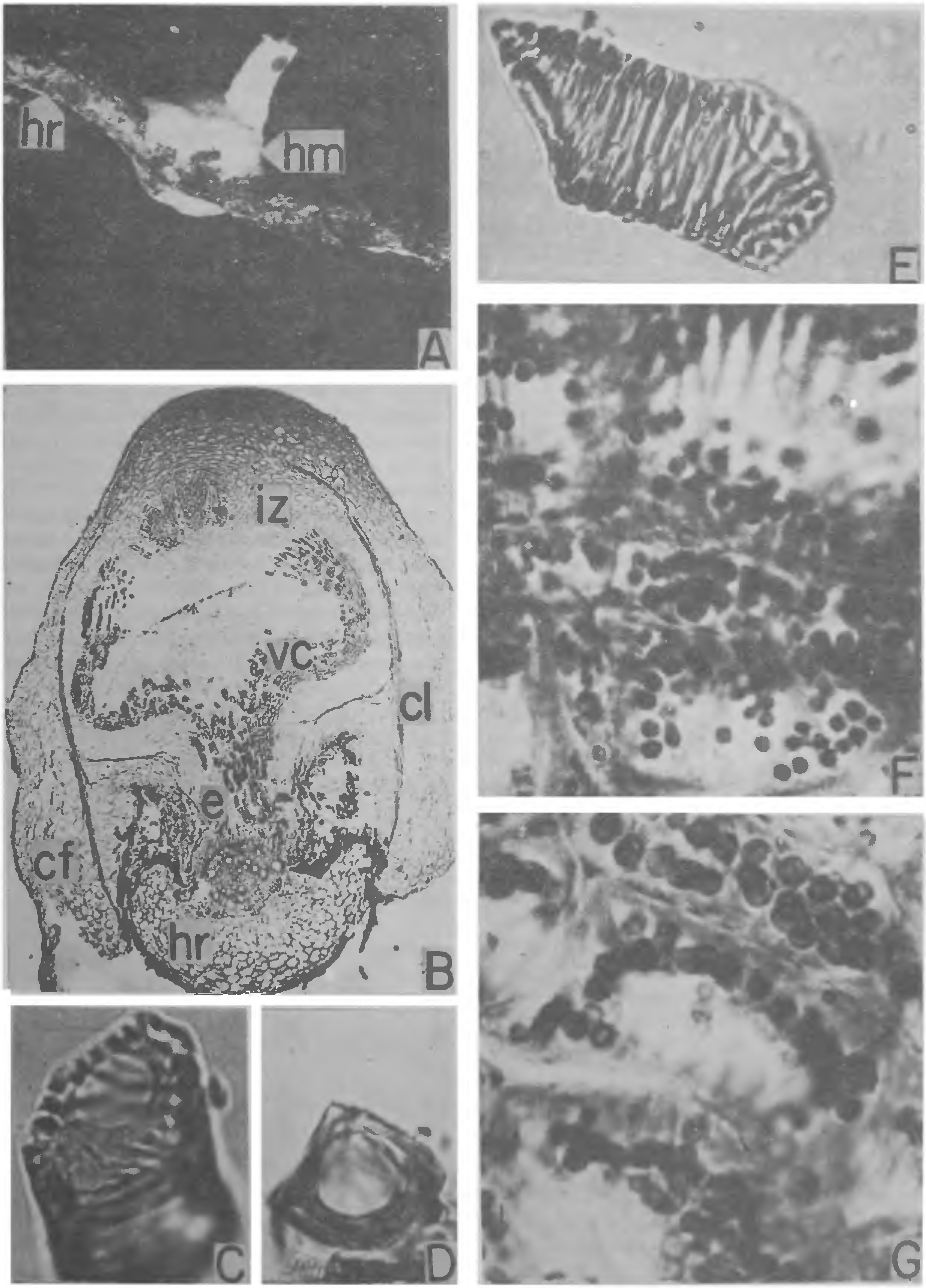
The tracheary elements in the vascular core of the haustorium are unique in possessing granular structures in their lumen (figures 1F–G). These spherical granules measure 0.5 μm to 4.5 μm in diameter. No connections were observed between the granules and the wall of the tracheary cells. The number of granules per tracheary cell varies and it decreases from the upper region of vascular core towards the endophyte. The positive response of granules to ninhydrin-Schiff's reagent and mercuric chloride-bromophenol blue (figure 1G) and a negative reaction to PAS test indicate their proteinaceous composition.

The presence of graniferous tracheary elements in the haustorium of *S. wallichianum* is reported here for the first time. Even though Benson[1] was the first to record these unusual structures in *Exocarpus cupressiformis* and *Thesium* of Santalaceae, it was left for later workers[2,3] to demonstrate them unequivocally in different species of the family. Since then graniferous tracheary elements have been reported in 24 species belonging to 12 genera of the Santalaceae[7,9].

Despite the discovery of graniferous tracheary elements in many taxa of Santalaceae[7], their functional role is yet to be resolved. Fineran[7] attributes a mechanical role to them i.e. the regulation of pressure and flow of sap from the host to the parasite. It is suggested[7] that the presence of a large number of imperforate tracheary cells—a result of retrogressive evolution from perforate tracheary cells—with granules in their lumen would regulate the pressure and movement of sap to and from between the parasite and the host; and that the variation in size and number of granules within xylem cells might indicate physiological differences between the two.

However, our studies on *Osyris arborea*[9] and the present work reveal the presence of a large proportion of perforate cells in the haustorium. Also, no appreciable variations could be observed in the haustoria of the same individual of *S. wallichianum* on different hosts as to correlate the physiological differences. If the function of imperforate xylem cells, derived 'secondarily' from perforate ones, along with granules is to impede the flow of sap, it is difficult to conceive why a perforation should be

Figures 1A–G. A. Haustorium (hm) of *S. wallichianum* on the root of *Hopea ponga* (× 2); **B.** Longitudinal section of the haustorium to show vascular core (vc), interrupted zone (iz), clasping folds (cf), collapsed layers (cl), endophyte (e), and the host root (hr) (× 24); **C–E.** Vessel elements of different shapes and sizes with simple perforation plates on transverse walls in C and D and on inclined walls in E. (× 950; × 550; and × 900 respectively); **F.** Granule-containing tracheary elements (× 1250); **G.** Positive response of granules to mercuric chloride-bromophenol blue staining combination (× 1370).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developed only to be lost in due course. In the absence of direct evidences, the above suggested function remains tentative.

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BIOCHEMICAL CHANGES DURING ANDROGENESIS IN *DATURA INNOXIA*

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Pollen grains can be induced to form embryoids and subsequently haploid plants under appropriate cultural conditions[1,2]. Our knowledge about the biochemical changes associated with this profound morphogenetic shift in the pollen grains is meagre. Some studies on nucleic acid metabolism have been carried out using cytochemical and autoradiographic techniques[3,4]. In the present investigation, changes in activities of peroxidase and α-amylase and the isozyme pattern of peroxidase have been studied vis-a-vis development of pollen grains *in vivo* and of pollen embryoids in cultured anthers of *Datura innoxia* Mill.

Excised anthers (6 mm) were cultured on MS medium[5] supplemented with 0.001 mg/l of kinetin. They exhibited swelling by the 10th day of planting and emergence of embryoids by the 25th day. Anthers (6 mm long) developing *in vivo* had uninucleate microspores, whereas those measuring 8–12 mm had binucleate pollen grains. The pollen

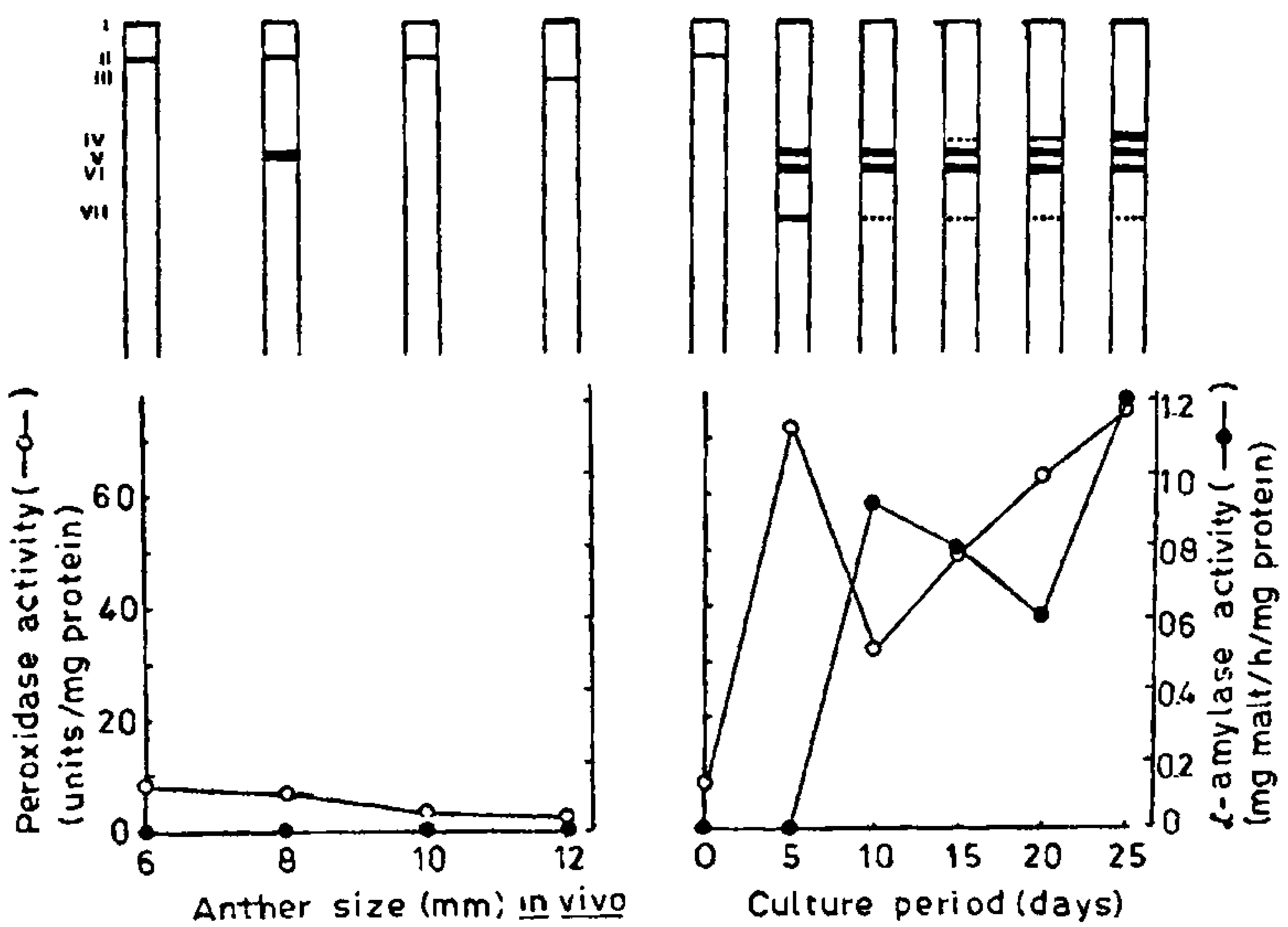

Figure 1. Changes in activities of peroxidase and α-amylase and isozyme pattern of peroxidase during development of anthers *in vivo* and *in vitro*.