narrow extending round the metabranchial lobe to join the base of the cardiac. The mesobranchial lobe was prominently developed and marked the highest elevation on the carapace.

The specimen has been deposited at the Department of Geology, Pachhunga University College, North-Eastern Hill University, Aizawl (no. 1).

Comparing with the known fossil Portunid crabs from the Indian Sub-continent, the specimen shows closer similarity to the *Portunus* (*Neptunus*) *arabicus* Woodword[1] (referred to as *Chrysbdis* by Glaessner[2]) described from Mekran coast, Baluchistan from a horizon doubtfully referred to Pliocene.

Portunus has a geological age range from Eocene to Recent. Most of the records of Portunid crabs from the Indian Sub-continent are from Miocene, excepting *Neptunus arabicus* whose exact horizon is still doubtful and *Neptunus sijuensis* reported from Eocene of Garo Hills, Meghalaya[3]. The extant *Portunes pelagicus* is a free swimming crab inhabiting the warm and temperate seas.

This work is a part of Ph.D. Dissertation of one of the authors (RPT). The authors thank G. S. Jaggi for help during the field work.

4 September 1987, Revised 4 March 1988

1. Woodword, H., *Geol. Mag.*, 1905, **2**, 305.
2. Glaessner, M. F., *Ann. Mag. Nat. Hist.*, 1933, ser. 10, **12**, 1.
3. Satsangi, P. P. and Parida, K., *J. Geol. Soc. India*, 1980, **21**, 305.

INDUCTION OF ROOTING IN CLADODE CUTTINGS OF *CASUARINA EQUISETIFOLIA*

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CASUARINA EQUISETIFOLIA L. has proven its capacity to establish itself in poor sites, particularly in the east coast of India. It can withstand stresses such as soil acidity, salinity, water stress (both flooding and drought), high temperature and high wind velocity[1]. Viable seed production in *C. equisetifolia* is good. Pollination is by wind and hence hybridization and genetic variation in progeny propagated by seed is obvious. Often, within a population there are individual trees that perform better than the others under acidic and saline conditions. Vegetative propagation would be the method of choice for large and rapid multiplication of such trees. This method can reduce the variation in the population and improve the yield. This paper presents the result obtained on rooting cladodes of *C. equisetifolia*. The cladode in *Casuarina* is a green, segmented modified branchlet. The extremely reduced leaves are barely visible and occur in whorls at the nodes of the cladodes. Tender cladodes (5–7 cm) without heel from the side shoots of 15-month-old *Casuarina* plants were excised in October, surface-sterilized by dip treatment in 0.1% Emision solution (mercuric chloride), and divided into three groups of 12 cladodes each. One group was used as control and the other two were treated with the rooting hormone indolebutyric acid (IBA) at 2000 and 4000 ppm. The hormone mixture was prepared by mixing 20 and 40 mg of crystalline hormone, for 2000 and 4000 ppm respectively, with 10 g of talcum powder in a rotary shaker. Control consisted of talcum powder without the hormone. The cut end of the cladode was dip-smeared with hormone mixture or talcum powder up to a length of one cm from the cut end. The treated cladodes were planted in 48 h-presoaked vermiculite in plastic trays and placed in a mist chamber. During the first 15 days, misting was given for 6 sec every 20 min during the day (9.00 a.m. to 7.00 p.m.) and every 50 min during the night (7.00 p.m. to 9.00 a.m.). After 15 days, when callus formation was observed in the cut ends of the cladodes, misting frequency was changed to once every 40 min during the days; misting frequency during the night was not changed. Root initiation was observed 20 days after planting. Rooting data were recorded 40 days after planting by carefully removing the cladode cuttings from the vermiculite and washing the roots under a water spray. For each group, the number of cladodes that rooted, number of roots per rooted cladode and average root length were recorded (table 1). The control cladodes failed to root. In the IBA 2000 group 2 out of 12 cladodes rooted, with 3 roots per

Table 1 *Rooting of cladode cuttings of Casuarina equisetifolia*

Treatment	Cladodes planted	Cladodes rooted	Roots per rooted cladode	Average root length
Control	12	0	0	0
IBA 2000	12	2	3.5 ± 0.1	1.0 ± 0
IBA 4000	12	12	13.8 ± 2.9	6.5 ± 0.7

Figure 1. Rooting in a cladode cutting of *Casuarina equisetifolia* dip-smeared with IBA 4000 ppm in talcum powder.

cladode. Treatment with 4000 ppm of IBA elicited 100% rooting response (figure 1). The results show that rooting percentage, number of roots per rooted cladode and average root length are maximal in cladodes treated with 4000 ppm of IBA. All the rooted cladodes were subsequently transplanted in soil and sand (1:1) in polythene bags and placed outside the mist chamber in shade. All the plants are grown normally (100% survival after transplantation).

The present results show that vegetative propagules of *C. equisetifolia* can be produced using cladodes. However, it must be emphasized that the high degree of success obtained in the present study was with cladodes obtained from 15-month-old plants. In many forest plants the vegetative material obtained from older trees fails to root despite hormone treatment[2]. In such plants attempts have been made to induce juvenile shoots in older trees by methods such as coppicing or hedging[3]. Trees show juvenility gradients, with epicormics, root suckers, stump sprouts and severely pruned trees producing juvenile shoots[4]. In *Eucalyptus*, branch and leafy cuttings taken from older trees fail to root but coppice sprouts root with a high degree of success[5]. In mature trees of *C. equisetifolia*, bunches of cladodes often arise sporadically on the main stem in the basal region. Root suckering of desired trees can also be stimulated to obtain juvenile cladodes. These cladodes can be rooted to produce new plants. Once a tree with desired characteristics such as better performance under acidic/saline conditions is identified, it can be cut or root suckers can be induced, and the bunches of cladodes rooted using the technique presented to produce a large number of vegetative propagules.

19 March 1988

1. Anonymus, *Casuarinas: Nitrogen fixing trees for adverse sites*, National Academy Press, Washington, D. C., 1984.
2. Kozlowski, T. T., *Growth and development of trees: Seed germination, ontogeny and shoot growth*, Academic Press, New York, London, 1971. Vol. 1. p. 112.
3. Franclet, A., In: *Clonal forestry: Its impact on tree improvement and our future forests*, (eds) L. Zsuffa, R. M. Rauter, and C. W. Yeatman, Canadian Tree Improvement Association, Ontario, Canada, 1983, p. 96.
4. Bonga, J. M. and Durzan, D. J., *Tissue culture in forestry*, Dr W. Junk Publishers, The Hague, Boston, London, 1982, p. 150.
5. Gurumurti, K., Bhandari, H. C. S. and Negi, D. S., *Indian For.*, 1988, **114**, 78.

IMPORTANCE OF CALCIUM AT BREEDING SITES OF FISHES

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Shell strength may be directly proportional to the availability and concentrations of its various components existing in the environment. Zotin[1] attributed shell strength of salmonids to calcium contents of the water at breeding habitats. He also demonstrated that calcium is necessary for the functioning of the hardening enzyme which acts during earlier stages of development, immediately after fertilization. In marine fishes the degree of hardening among eggs depends upon the time the eggs are exposed to sea water[2] (access to excess calcium). Calcium is necessary for both insegmented and