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Lepidosaphes pinnaeformis Bouche (Hemiptera: Diaspididae): An emerging problem on orchids in India

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Abstract

The mountainous states of India and neighboring countries Nepal, Tibet and Bhutan assist large habitats for diverse orchid species. Present study revealed the orchid species in natural habitat and its hybrids growing in the farms under controlled conditions suffered from various biotic stresses. This species of scale insect reported as orchid pest in Indian subcontinent long back in the 1950s but no published records have documented *L. pinnaeformis* on orchids in the country so far. We report results of a survey conducted in five different locations of North East India including own institute farm (Pakyong, Sikkim) from 2012 to 2013. We infer that orchid scale, *Lepidosaphes pinnaeformis* Bouche (Hemiptera: Diaspididae), is an emerging pest causing medium to heavy damage to orchids round the year at different altitudinal range of the territory.

Keywords: scale insect, orchids, damage level, northeastern himalayan states, India

Introduction

Orchidaceae is the species richest family of flowering plants. An estimate of the number of species in the orchidaceae is determined to be 19128^[1]. However, the numerical strength of the family in terms of number of species is reached to more than 25000 from 880 genera all over the world^[2, 15]. India is blessed with 1229 species, spreading from tropical to temperate provinces^[3]. Orchids are in cultivation for the conservation of genetic resources, trade of orchid species, cut flowers, potted plants and other valued products^[4]. Orchids display great diversity in form, size, colour and texture beyond human imagination. Among the various categories of orchids, *Cymbidium*-an epiphytic orchid, with its high value flowers, is ranked among the top 10 cut flowers and it occupies a proud position in global cut flower trade. Its flowers can remain fresh for a long up to one month in normal water which enhances their ornaments value^[5].

The orchid scale, *Lepidosaphes pinnaeformis* Bouche (Hemiptera: Diaspididae) is to be considered a pest of orchids and particularly *Cymbidium*, as it causes round the year damage in the natural habitats and farms located in mid to higher elevations of Sikkim, India. Here temperature ranges from 19 to 29^o Celsius and relative humidity is between 65 - 80 percent^[6]. This species of scale has not only spread to the entire north eastern parts of India including Darjeeling district of West Bengal state but also to the neighboring countries viz., Nepal, Tibet and Bhutan. *Lepidosaphes pinnaeformis* is often difficult to detect because of its small size and concealed habit of remaining beneath leaf sheaths and crevices. The crawlers can disperse over short distances within the plants, resulting in the spread of new colonies. Both nymphs and adults feed on pseudo-bulbs, leaves, flower buds and even full bloomed flowers. Due to removal of cell sap and nutrients, leaves become yellow, turning brown to black with time and plant vigor deteriorates leading to the death of the plant. Scales are difficult to control in orchids because of their inaccessibility to insecticides and protective covering. Several insecticides and formulations are commercially available but these are effective if applied at crawler emergence stage. Although, Cating *et al.*^[7] suggested the application of Silwet® L-77 plus petroleum oil to suppress scale populations on orchids. Use of scale free planting material, careful monitoring at regular intervals to detect the emergence and establishment of crawlers, removal and destruction of infested plant parts are important in its management. Apart from the damage, it causes to orchids in cultivation under protected conditions, the scale also poses a direct threat to rare, threatened and endangered native orchids in their natural

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habitat in north east India. In this article, we update on the status of *L. pinnaeformis* on *Cymbidium* and other orchid species in growers' farms and five sites in forests of northeastern states of India.

Materials and Methods

Study Sites

The ICAR-National Research Centre for Orchids, Pakyong, lies at 27°13'60" N and 88°35'60" E in the mountainous state of Sikkim, India. The centre has a collection of 350 orchid species and hybrids in its conservatory. We surveyed orchid populations for *L. pinnaeformis* infestation in the forest under natural habitation and orchid farms under polyhouse and partial shade in 2012 and 2013. Five sites (own institute's farm and four other sites, namely Namchi, South Sikkim; Darjeeling, West Bengal; Shillong, Meghalaya and Pasighat, Arunachal Pradesh in northeastern Himalaya) were taken into study. These sites share geographical boundaries with the neighboring countries, Nepal, Bhutan and China (Tibet). The information on geo-coordinates and prevailing pest management practices of each surveyed locations is presented in Table 1 and Figure 1. Three of these farms followed conventional pest management practices, the remaining two farms were not sprayed with any insecticides before and during the period of study. The Pasighat (Arunachal Pradesh) site consisted of thick and dense forests extending on both sides of Siang river basin. The epiphytic orchids of this site grow on tree species like *dhale katus* (*Castanopsis indica*), oak (*Quercus lamellose*), phul-sopa (*Michelia oblonga*), tasichang (*Ostodes paniculata*), chilaune (*Schima wallichii*) and *Ficus* spp. The other three sites viz., Namchi, Darjeeling and Shillong lie between an elevations of 1500-2500 meters in northeastern Himalaya. The orchid species in these areas grow on trees like guras (*Rhododendron arboreum*), sal (*Shorea robusta*), chilaune (*Schima wallichii*), *Ficus* spp., *katus* (*Castanopsis indica*), pines and conifers. The canopy of these trees creates congenial conditions for luxurious growth of orchids round the year.

Orchid species

Sixteen orchid species: *Cattleya maxima* Lindl., *Coelogyne corymbosa* Lindl., *Coelogyne nitida* (Wall. ex. Don) Lindl., *Cymbidium lowianum* (Rchb. f.), *Cymbidium tigrinum* Paris ex. Hook F., *Cymbidium tracyanum* Rolfe, *Cymbidium mastersii* Griff ex. Lindl., *Cymbidium aloifolium* (L.) Sw., *Dendrobium aduncum* Wall. ex. Lindl., *Dendrobium moschatum* Sw., *Dendrobium nobile* Lindl., *Epidendrum radicans* Pavon ex Lindl., *Eria cristata* Rolfe, *Pholidota articulata* Lindl., *Phaius flavus* (Bl.) Lindl., and *Vanda coerulea* Griff. ex Lindl., were surveyed for *L. pinnaeformis* infestation in the forest under natural habitation and also under polyhouse and partial shade conditions. Of these orchids surveyed, few species are rare, threatened as well as endangered in the nature in India that needs to be conserved¹⁸⁻⁹¹. We collected the leaves and pseudo bulbs from each location for *L. pinnaeformis* infestation during different period in 2012-13. After examining the samples in the field, infested plant material (leaves and pseudo bulbs) was transported to the laboratory where they were examined under a stereo zoom microscope (Leica MZ 12₅) and percent infestation of orchids was assessed. Identification of orchid scale was confirmed by Division of Insect Systematics, ICAR-National Bureau of Agricultural Insect Resources, Bangalore (Karnataka state), India.

Results

At own institute's farm (Pakyong, Sikkim), a total of 175 orchid species and 57 hybrids were evaluated for scales infestation under polyhouse and partial shade conditions. Of these orchids, *L. pinnaeformis* occurred on 16 species from 9 different genera: *Coelogyne* (2 species), *Cymbidium* (5 species), *Dendrobium* (3 species) and 1 species each from *Cattleya*, *Epidendrum*, *Eria*, *Pholidota*, *Phaius* and *Vanda* (Table 2). *Lepidosaphes pinnaeformis* was reported decades ago and presently no descriptions as published documents are available in India. The per cent incidence of *L. pinnaeformis* was varied due to orchid species and existing environmental conditions. Other than orchid species, the *L. pinnaeformis* was also recorded on *Cymbidium* hybrids: 'Pine Clash Moon Venus', 'Show Girl', 'H.C. Aurora', 'Mint Ice Glacier', 'Red Star', 'Margaret Thatcher', Levis Duke 'Bella Vista', 'Sleeping Nymph' and 'Cecil Park'. Of 150 potted plants (five years old) each of *Cymbidium* hybrids 'Pine Clash Moon Venus' and 'H.C. Aurora', maintained under polyhouse conditions at Pakyong, Sikkim were evaluated for *L. pinnaeformis* infestation. It was found that 134 plants (89% infestation) of 'Pine Clash Moon Venus' and 107 plants (71% infestation) of 'H.C. Aurora' were found significantly damaged having its average population density 33 scale crawlers/leaf.

Overall, among the 754 orchids surveyed, *L. pinnaeformis* occurred on 30.9%, wherein *Cymbidium* species were most preferred (39 to 60%) and *Eria cristata* was least preferred (12.5%) orchid host in the forest under natural habitation (Table 2). Surveys report revealed that *Lepidosaphes pinnaeformis* was present at all five sites with diverse infestation level. Under natural habitation in the forest, all 16 surveyed orchid species (28.9% plants) were infested with *L. pinnaeformis* at Pakyong (East Sikkim). Of 14 orchid species surveyed, 12 species (34.7%) were infested with the pest, but no infestation was recorded on either *C. tracyanum* or *E. cristata* at Namchi (South Sikkim). Similarly at Darjeeling (West Bengal), among the 10 orchid species surveyed, *Coelogyne corymbosa*, *C. nitida*, *Cymbidium lowianum*, *C. tigrinum*, *C. tracyanum*, *C. mastersii*, *Epidendrum radicans* and *Phaius flavus* were infested with *L. pinnaeformis*, whereas no infestation was found on either *C. aloifolium* or *D. moschatum*. Similar data were recorded for Shillong (Meghalaya), where *Coelogyne corymbosa*, *C. nitida*, *Cymbidium lowianum*, *C. tigrinum*, *C. mastersii*, *C. aloifolium*, *Dendrobium aduncum*, *D. moschatum*, *D. nobile*, *E. radicans* and *P. flavus* were infested with *L. pinnaeformis*; no infestation was found on either *E. cristata* and *P. articulata* (Table 2). At Pasighat (Arunachal Pradesh), only six orchid species: *Cymbidium lowianum*, *C. tigrinum*, *C. tracyanum*, *C. mastersii*, *Dendrobium aduncum*, and *D. moschatum* were infested and two species (*Coelogyne corymbosa* and *Pholidota articulata*) appeared free of scale. Of 16 orchid species surveyed, only 2 species, namely: *Cymbidium lowianum* (Rchb. f.) (60% plant infested) and *Cymbidium tigrinum* Paris ex. Hook F. (39% plant infested) were infested with *L. pinnaeformis* in all five sites surveyed, designated as most preferred orchids to *L. pinnaeformis*.

Simultaneously, a survey was also conducted in the orchid farms at five same locations for *L. pinnaeformis* infestation under polyhouse and partial shade conditions. Among 715 plants of orchid species surveyed, *L. pinnaeformis* occurred on 57.3% (Table 3). The similar trend of scale incidence was obtained, as *Cymbidium* species were the most preferred (57.8

to 82.9%) and *Epidendrum radicans* was least preferred (8.3%) orchid host. Of 16 orchid species surveyed, 14 species (54.7% plants) were infested with *L. pinnaeformis*, whereas *E. radicans* or *E. cristata* were free from scale infestation at Pakyong (East Sikkim). Similarly four other locations, 10 orchid species (69.3% plants) were infested at Namchi (South Sikkim), 10 species (55.9% plants) at Darjeeling (West Bengal), 9 species (55.5 % plants) at Shillong (Meghalaya) and 6 orchid species (35.2% plants) were infested with *L. pinnaeformis* at Pasighat (Arunachal Pradesh), whereas no infestation was found on either *Cymbidium aloifolium* or *Dendrobium moschatum*. We report results of surveys at five sites indicated that the infestation of *Lepidosaphes pinnaeformis* was more severe in the orchid farms than forest under natural habitation (Table 3).

Infestation of *L. pinnaeformis* was found on leaves, stems, pseudo bulbs, and roots of orchid hosts. The insect was mostly observed near the midrib of leaves or beneath the leaf sheaths or on the roots inside potted media which protected them against natural enemies as well as provided protection from pesticides. Due to heavy damage of scale, infested plants produced inferior quality flowers. In the absence of control measures, flower production and quality got drastically reduced.

Life Cycle of *L. Pinnaeformis*

After settling in suitable places on the host plants, the adult female covers the entire body with encrustation which is 2.5 – 5.0 mm long, elongated, mussel-shaped, slightly convex, straight or curved as teardrop, yellowish to dark brown colored with paler margin (Fig 2c). The encrustation of an adult male is similar to that of female but smaller (1.5 – 2.6 mm long) and narrower, with terminal exuviae. Females lay eggs retained in the body inside the encrustation and crawlers (0.5 – 0.7 mm long) emerged out when mother dies. Newly

emerged crawlers move to new areas and disperse on the plant parts for settling and feeding after searching suitable succulent portion of the plants. Feeding results in the appearance of small, rod or oval shaped dotted spots on new leaves which later enlarge and cover the entire leaves (Fig. 2a & 2b).

Discussion

Initial surveys indicated the emergence of the scale on orchid species and hybrids in both forest in natural habitation and protected cultivation under controlled conditions. Of the 754 orchid species surveyed in five different locations of the northeastern Himalayan states, we recorded *L. pinnaeformis* infestation on 30.9% orchid hosts (unpublished data). There was no evidence available on *L. pinnaeformis* infestation in India so far, hence, results could not be discussed and compared. However, Nagrare *et al.* [10] documented the boisduval scale, *Diaspis boisduvalii* as severe pest causing damage to leaves, canes, root and flowers of *Dendrobium*, *Cattleya* and *Epidendrum* orchids in Sikkim, India. In tropical America, *D. boisduvalii* was observed to cause losses on *Oncidium* and *Zygopetalum* in greenhouses Johnson [11] and brown soft scale, *Coccus hesperidum* on hibiscus, palms and orchids Malais and Ravensberg [12]. Scale insects are a severe problem in orchids worldwide Pritchard [13] supported to the present study. Three more specie of scales viz., ti scale, *Pinnaspis buxi* (Bouche), lecanium scale, *Lecanium* sp. and florida red scale, *Chrysomphalus aonidum* (L.) were also recorded as endemic and feeding on the leaves, root and flowers of many species of orchids in India (Meena *et al.*) [14]. However, the occurrence of *L. pinnaeformis* on orchids in India is becoming serious and, become more serious; hence, it has been reported as an emerging problem on orchids in the country.

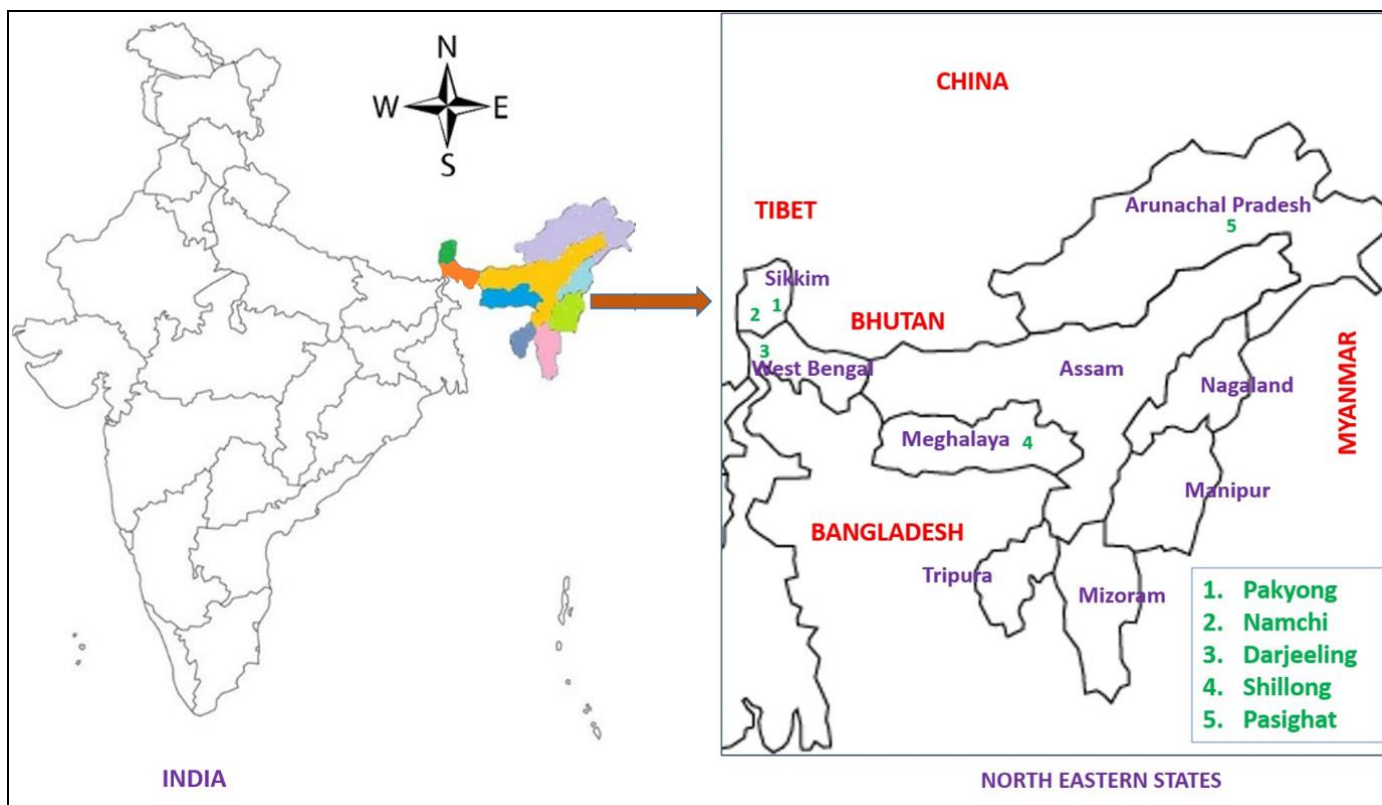


Fig 1: Map showing different locations surveyed in northeastern Himalayan states of India



Fig 2: *Lepidosaphes pinnaeformis* in orchids: 2a) Infested plant of *Cymbidium*. 2b) crawlers *L. pinnaeformis* covering their body with encrustation on succulent part of leaves. 2c) close-up view of *Lepidosaphes pinnaeformis* on leaf of *Cymbidium* orchid

Table 1: Geographical information about locations surveyed in northeastern states of India.

Location name	State	Approximate coordinates (latitude, longitude)	Pest management practices adopted
Pakyong (East Sikkim)	Sikkim	27° 13' 60'' N; 88° 35' 60'' E	Unsprayed
Namchi (South Sikkim)	Sikkim	27° 10' 00'' N; 88° 22' 00'' E	Unsprayed
Darjeeling	West Bengal	26° 31' 0'' N; 87° 59' 0'' E	Conventionally sprayed
Shillong	Meghalaya	25° 34' 32'' N; 91° 52' 23'' E	Conventionally sprayed
Pasighat (East Siang)	Arunachal Pradesh	28° 04' 12'' N; 95° 19' 48'' E	Conventionally sprayed

Table 2: Scale, *Lepidosaphes pinnaeformis* found on orchid species at five sites surveyed in 2012 and 2013 at northeastern states of India in the forest under natural habitation.

Orchid species	Sites surveyed					Total
	Pakyong (East Sikkim)	Namchi (South Sikkim)	Darjeeling (West Bengal)	Shillong (Meghalaya)	Pasighat (Arunachal Pradesh)	
<i>Cattleya maxima</i> Lindl.	14* 6**	6 2	-	-	-	20 8 (40)
<i>Coelogyne corymbosa</i> (R)	26 8	3 1	10 3	10 3	5 -	54 15 (27.7)
<i>Coelogyne nitida</i> (mC)	36 6	11 4	20 6	6 1	-	73 17 (23.2)
<i>Cymbidium lowianum</i>	9 7	15 8	5 3	2 1	4 2	35 21 (60)
<i>Cymbidium tigrinum</i>	16 5	5 3	6 2	5 2	9 4	41 16 (39)
<i>Cymbidium tracyanum</i>	10 8	3 -	11 6	-	3 1	27 15 (55.5)
<i>Cymbidium mastersii</i> (E)	15 11	-	5 2	15 7	6 2	41 22 (53.6)
<i>Cymbidium aloifolium</i>	22 14	13 4	2 -	8 3	-	45 21 (46.6)
<i>Dendrobium aduncum</i>	20 4	8 2	-	5 1	13 6	46 13 (28.2)
<i>Dendrobium moschatum</i> (R, E, T)	35 13	14 6	6 -	7 3	19 5	81 27 (33.3)
<i>Dendrobium nobile</i> (E, T)	86 15	16 5	-	5 2	-	107 22 (20.5)
<i>Epidendrum radicans</i>	30 6	7 2	3 1	12 3	-	52 12 (23)
<i>Eria cristata</i> Rolfe	15 3	6 -	-	3 -	-	24 3 (12.5)
<i>Pholidota articulata</i>	10 2	9 3	-	3 -	6 -	28 5 (17.8)
<i>Phaius flavus</i> (Blume)	20 3	-	5 2	6 2	-	31 7 (22.5)
<i>Vanda coerulea</i> (T)	40 6	2 1	-	7 2	-	49 9 (18.3)
Orchids surveyed	404	118	73	94	65	754
Scale infested	117 (28.9)	41 (34.7)	25 (34.2)	30 (31.9)	20 (30.7)	233 (30.9)

*Total orchids surveyed at each locations; **infested orchid plants. The numbers in parentheses represent the percentage of individual plants infested.

#R-Rare, mC-most common, E-endangered, T-threatened.

Table 3: Scale, *Lepidosaphes pinnaeformis* found on orchid species at five sites surveyed in 2013 in the orchid farms under polyhouse and partial shade conditions.

Orchid species	Sites surveyed					Total
	Pakyong (East Sikkim) US	Namchi (South Sikkim) US	Darjeeling (West Bengal) CS	Shillong (Meghalaya) CS	Pasighat (Arunachal Pradesh) CS	
<i>Cattleya maxima</i> Lindl.	20* 12**	12 6	-	3 2	-	35 20 (57.1)
<i>Coelogyne corymbosa</i> (R)	20 11	-	10 6	5 2	5 2	40 21 (52.5)
<i>Coelogyne nitida</i> (mC)	50 27	15 9	23 13	10 4	-	98 53 (54.0)
<i>Cymbidium lowianum</i>	15 13	10 10	8 4	-	-	33 27 (81.8)
<i>Cymbidium tigrinum</i>	15 8	5 3	10 6	-	10 7	40 24 (60)
<i>Cymbidium tracyanum</i>	8 6	6 4	8 5	10 5	6 2	38 22 (57.8)
<i>Cymbidium mastersii</i> (E)	15 10	-	-	20 12	7	35 29 (82.9)
<i>Cymbidium aloifolium</i>	40 32	20 18	15 12	15 10	5	95 72 (75.7)
<i>Dendrobium aduncum</i>	35 19	-	10 4	-	-	45 23 (51.1)
<i>Dendrobium moschatum</i> (R, E, T)	20 12	10 6	10 5	6 3	-	46 26 (56.5)
<i>Dendrobium nobile</i> (E, T)	65 28	20 14	9 4	-	10 4	104 50 (48)
<i>Epidendrum radicans</i>	9 -	-	-	-	3 1	12 1 (8.3)
<i>Eria cristata</i> Rolfe	10 -	6 3	-	-	-	16 3 (18.7)
<i>Pholidota articulata</i>	10 6	-	-	-	8 3	18 9 (50)
<i>Phaius flavus</i> (Blume)	15 5	7 4	6 2	3 1	-	31 12 (38.7)
<i>Vanda coerulea</i> (T)	20 12	-	-	9 6	-	29 18 (62)
Orchids surveyed Scale infested	367 201 (54.7)	111 77 (69.3)	109 61 (55.9)	81 45 (55.5)	54 19(35.2)	715 410 (57.3)

*Total orchids surveyed at each locations of northeastern states; **infested orchid plants. The numbers in parentheses represent the percentage of individual plants infested. #US-Unsprayed; CS- Conventionally sprayed.

R-Rare, mC-most common, E-endangered, T-threatened.

Conclusion

India's mountainous states viz., Sikkim, Arunachal Pradesh, Meghalaya, Darjeeling district of West Bengal, Assam, Manipur, Mizoram, Tripura contain huge habitats for diverse orchid species. From the study it was showed that the orchid species in natural habitat and its hybrids growing in the farms under controlled conditions infested by a number of pest species. *Lepidosaphes pinnaeformis* Bouche is one of the species of scale insect reported as orchid pest in Indian subcontinent long back in the 1950s but no published records have documented *L. pinnaeformis* on orchids in the country so far. Based on the results of a survey conducted in five different locations of North East India including own institute farm (Pakyong, Sikkim) from 2012 to 2013. It is concluded that orchid scale, *Lepidosaphes pinnaeformis* Bouche (Hemiptera: Diaspididae), is an emerging pest causing medium to heavy damage to orchids round the year at different altitudinal range of the territory can be a immense future pest problem in orchids in the forest under natural habitation as well as in the orchid farms.

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