INCIDENCE OF OAK BORERS AND OAK MORTALITY IN GARHWAL HIMALAYA, INDIA

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Introduction

The Western Himalayan oaks, Ban, *Quercus leucotrichophora* Camus; Moru, *Q. dilatata* Lindl. and Kharsu, *Q.semecarpifolia* Smith play a vital role in conservation of the environment and in meeting the social needs of villagers living in the Western Himalayas in India. These trees are an important source for making agricultural tools, fuel wood and charcoal while the foliage is most extensively lopped for fodder. In recent years oak forests have witnessed a steady decline in the region due to intense biotic pressure on these forests mainly due to over exploitation as a consequence of lopping and grazing. Periodic occurrence of oak decline over wide spread areas have been reported since 1900 all over the world (Wargo *et al.,*1983). Oak decline is known to be caused by a complex interaction of environmental stresses and pests. The initiating factors associated with oak decline are mainly drought, frost injury or insect defoliation. Besides defoliators, oak decline in the Western Himalayas is caused by the damage done by the stem boring beetles, capable of causing oak mortality (Beeson,1941). Mathur and Singh (1959) have listed insect pests of *Quercus* spp. which includes 46 species on *Q.leucotrichophora*, 28 species on *Q.dilatata* and 14 species on *Q.semicarpifolia* are wood boring beetles, both primary and secondary borers.

Material and Methods

Random sampling surveys were carried out from May-December in oak growing forest areas along with baseline stand parameters in Garhwal (Dehradun, Tehri Garhwal, Pauri, Uttarkashi, Chamoli and Rudrprayag districts) of Uttarakhand state, from July 2007 to December 2009, to know the incidence of borers, their nature and extent of damage, natural enemies and biotic interferences. Forest sites surveyed include:

Govind Wildlife Sanctuary (Uttarkashi district), Chakarata-Deoban-Kanasar Reserve Forests, Benog Wildlife Sanctuary in Mussoorie Forest Division, Dhanaulty; Kaddukhal; Kanatal and Reserve Forest areas in Buddha Kedar-Pangarana area (Tehri Garhwal district),Mandal-KanchulaKharak-Tala Village (Chamoli district), Reserve Forest areas of Adwani, Kandolya, Khirsu and Chaurikhal (Pauri Garhwal district). Observations include percentage of borer infested oak trees in a stand (species wise), Girth at Breast Height (GBH) and density of oak trees in infested sites by laying down 10 quadrates (10 x 10m), altitudinal range of the oak stands, percentage of lopped oak trees in the stand for classifying them into 4 classes (1=<25%; 2=25-50%; 3=50-75% and 4=>75%), incidence of past and present grazing in the oak stands. Based on visual observation of the state of shrub layer (Low- Good undergrowth; Moderate-Presence of some under storey plant species; Heavy- Practically no undergrowth), management history of oak stands (reserve forest; sanctuary; village forest, etc.), Collection of insect material (beetles and grubs) and infested oak logs. All the emerging beetles and their parasitoids were identified. Identification was carried out at the National Forest Insect Reference Collection at FRI, Dehradun, India.

Results and Discussion

Out of the six sites surveyed, borer infested oak trees were recorded in only three sites. Two species primary borers, eleven species of secondary borers and two species of natural enemies of these borers along with 4 species of woodpeckers also as natural enemies of these borers were observed.

Primary borers

1. *Aphrodisium harwickianum*White (Coleoptera: Cerambycidae). Emergence of these metallic green coloured, 32-45 mm longhorn beetles took place during June from crescent shaped emergence holes on tree trunks of *Q. leucotrichophora* in Dangan village where infestation was 23% during (June 2007-July 2008). This is a borer of both sapwood and heartwood with annual life cycle. Visible symptoms of attack were drying of leaves on branches and stem, many crescent shaped emergence holes on the stem and small ejection holes in the branches and accumulation of dust heap on the ground. The larval galleries in the stem lead to the main stem. A dead *Q. leucotrichophora* tree (1.73 m gbh-GBH) in Dangan village revealed as many as 38 larval galleries (100-210mm long) and 12 emergence holes (20-30mm wide and crescent shaped) on a single tree all located 1.3 m above the ground level on the tree trunk. Besides, one *Q. dilatata* tree growing adjacent to an infested *Q. leucotrichophora* tree was also attacked by this beetle as typical crescent shaped exit holes were also visible on this tree. This is the first record of attack by this borer on *Q. dilatata*. Incidence (19%) of this borer was also

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recorded from lopped tree stands of *Q. leucotrichophora* in Duni village (1900m), Govind WL Sanctuary in Nov-Dec 2009; Chakarata Cantonment Forest (9% in July 2009) and in Benog WL Sanctuary, Mussoorie (1% in May 2007). All the Ban oak trees attacked in Govind WL Sanctuary were heavily lopped.

Oak stem borer *Aphrodisium harwickanum* is known to attack *Quercus leucotrichophora* in the western Himalayas. Attack of several generations kill trees by destroying the stem, and even when the host survives its timber is rendered useless for anything but firewood (Khan and Bhatia, 1946; Beeson, 1941; Browne, 1968). Reports of its occurrence on *Q. leucotrichophor*a trees have been reported from Dharamsala, Kangra Forest Division, Himachal Pradesh; Sitoli in Almora and Bhimtal in Nainital district of Uttarakhand (Khan and Bhatia, 1946). The attack of this borer in Dangan village (Haltari Blocks 1A&B in Supin range) was first noticed in year 2002 (Rawat *et al*., 2003).

2. *Rosalia laterifolia* Hope (Coleoptera: Cerambycidae). Attack of this red longhorn 25-33m long beetle was evident during July 2008 in Deoban Reserve Forest (Compartments 6 B; 9A & 9B), Chakarata Forest Division, Dehradun District, Uttarakhand on *Q.dilatata* and *Q. semecarpifolia* trees. In all 28% of the trees of both the species were attacked in patches in these three compartments. Visible symptoms of attack were drying of leaves on branches and stem and accumulation of dust heap on the ground. The emergence holes of this beetle were round in shape (20mm wide) located ca.1m above the ground on the tree trunk. Grubs were collected during May-June from *Q. dilatata* lower branches close to the stem. Adult beetles of both the sexes were collected from already infested oak trees from the bark during July 2009. Specimens of this beetle have previously been collected from *Q.dilatata* trees in Deoban-Mudali blocks, Chakarata Forest Division during 1921-1933 (National Forest Reference Insect Collection (NFRIC) at FRI, Dehradun).

Secondary Borers

Crossotarsus fairmeri Champion (Coleoptera: Platypodidae): Attack of these 6 mm, brownish coloured beetles was evident in Deoban Reserve Forest, (Compartments 9A and 9B), Chakarata Forest Division during July 2009 on *Q. dilatata* and *Q. semicarpifolia* trees infested by the stem borer, *Rosalia laterifolia*. A large number of these beetles make extensive small sized galleries in the sap wood. Emergence of these beetles took place during August 2009 from *Q.dilatata* logs brought from Deoban in July 2009. Host range of this borer includes *Abies pindrow, Acer caesium, Cedrus deodara, Juglans regia, Picea morinda, Pinus excelsa, Prunus pardus, Quercus dilatata, Q.incana* and *Q. semicarpifolia* (Beeson, 1941). It is secondary borer but initiates attack on infested and dying trees. Specimens have been previously collected from Kunain, Mundali and Chakarata in this division during May-June, 1915-1934 (NFRIC, Dehradun).

Dryocoetes hewetti Stebbing (Coleoptera: Scolytidae).These tiny (3-4 mm) light brown coloured beetles emerged in October2009 from borer infested *Q.dilatata* branches collected during July 2009 from Deoban Reserve Forest (compartment 6 B),Chakarata Forest Division. Host range also includes *Q.leucotrichophora* (Beeson, 1941). Previously it was collected from *Q. dilatata* from Deoban (1915) and Mundali (1924 and 1933) in Chakarata Forest Division (NFRIC, Dehradun).

Tetropium orienum Gahan (Coleoptera: Cerambycidae). These 10-17mm long, dark brown to black longhorn beetles emerged from *Q.dilatata* logs in April 2008 in rearing cages which were collected from Dangan village, in Govind Wildlife Sanctuary during August 2007. It is a secondary borer of freshly fallen and diseased *Cedrus deoadara*, *Picea smithian* and *Pinus wallichiana* trees and its emergence takes place from May-July. Life cycle is annual. Larvae make irregular, frass-filled tunnels between bark and wood and then after overwintering enter the wood. Pupal chamber is made in the bark (Gardner, 1927; Beeson, 1941; Browne 1968). Previously, specimens have been collected from Deoban (1915), Kansar (1932) and Bodyar (1924) in Chakarata Forest Division (NFRIC,Dehradun).

Aglaophis fasciatus Thoms. (Coleoptera: Cerambycidae)- Emergence of these 10-12mm long beetles grey with black markings took place during March 2010 in rearing cages from Moru Oak, *Quercus dilatata* logs brought from Deoban, Chakarata forest division during July 2009. Borer of *Q. lamellosa* with 2 generations per year (Beeson, 1941). Previously specimens of this species have been collected from Kullu, Himachal Pradesh (1935); Chakarata Forest Division (1922); Dudatoli, Pauri Grahwal (1920); from *Q. leucotrichophora* in West Almora (1918) in Uttarakhand and from *Q. lamellosa* in Darjeeling, West Bengal (1929) (NFRIC, Dehradun).

Xylotrechus basifulginosus Hell. (Coleoptera: Cerambycidae). Emergence of these 15mm long black beetles with yellow markings took place in rearing cages at FRI during March'2010 from *Q. dilatata* logs collected during July 2009 from Deoban Reserve Forest, Chakarata Forest Division. Host range of this species includes *Picea*

smithiana, *Quercus semecarpifolia, Quercus* sp. (Beeson, 1941). Previously specimens of this species have been collected from Tharoch in Shimla district (1924) and Kangra (1951) in Himachal Pradesh; Deoban (1915), Chakarata (1916; 1924 and 1933); and Mundali (1933) in Chakarata Forest Division, Uttarakhand (NFRIC, Dehradun).

Perissus quercus Gardner (Coleoptera: Cerambycidae)- Emergence of these 13mm long black beetles with pale lines, from borer infested *Q. dilatata* logs took place in rearing cages in July 2009 that were collected from Dangan Village, Govind Wildlife Sanctuary in July 2008. This is a borer of bast and sapwood with annual life cycle. Recorded host plant is *Q. leucotrichophora* (Beeson, 1941). Previously collected from *Q. leucotrichophora* in Mundali, Chakarata Forest Division (May 1933) and Someswar, Almora (May 1937) (NFRIC, Dehradun).

Demonax albicinctus Hope (Coleoptera: Cerambycidae)- Emergence of these 4-5 mm long, black beetles with pale lines, took place from borer infested *Q. dilatata* logs in May 2008, April and May 2010 in rearing cages, collected from Dangan village, during August 2007. There is no previous record of this borer on West Himalayan oaks. It is also a borer of dead twigs and logs.

Demonax nigro-maculatus Gahan (Coleoptera: Cerambycidae)- Emergence of this 15mm beetle light yellow beetle with black markings took place from *Q.dilatata* logs during May 2008 in rearing cages collected from Dangan village during July2007. Previously collected from Gwaldam, Chamoli district,Garhwal (May 1937) and Bhowali, Kumaon (May 1912).

Margites sp. (Coleoptera : Cerambycidae). This 20 mm long light brown coloured beetle emerged during May 2008 from *Q.dilatata* logs collected from Dangan village in Govind Wildlife Sanctuary . It is a borer of sap wood.

Setenis cribrifrons Fairmarie (Coleoptera: Tenebrionidae). These dark brown beetles, 20 mm long, were collected during August 2008 from borer infested *Q. dilatata* logs in Dangan village. It is a borer of rotting wood. Other reported hosts of this borer are *Alnus nitida, Cedrus deodara, Pieris ovalifolia, Q. leucotrichophora* in the Himalayas. Beetles emerge in May-June (Beeson,1941).

Rhomborrhina glaberrima Westwood (Coleoptera: Scarabaedae). These 23-25mm metallic green colored beetles were collected from rotting wood in the trunk of dying *Q. dilatata* during July 2009 in Deoban (compartment 6 B), Chakarata Forest Division. It is a borer of rotting wood. Previously collected from Mussoorie (Sept.1921) (NFRIC, Dehradun).

Natural enemies of borers

Insects

Elatrid Beetle (Coleoptera: Elatridae). These, 10mm long, metallic brown coloured beetles emerged during April 2008 from *Q. dilatata* logs collected from Dangan village, Govind Wildlife Sanctuary during August' 2007. They are predaceous on wood boring larvae of other beetles.

Spathius sp. (Hymenoptera: Braconidae: Doryctinae). Emergence of these parasitoids took place during August2007 from borer infested *Q. dilatata* logs collected during July 2007 from Dangan village, Govind Wildlife Sanctuary. This genus has been reported as larval parasitoids of Bostrycid and Curculinid beetle larvae.

Birds (Aves: Picidae)

Four species of woodpeckers (Aves: Picidae) were also recorded feeding on grubs of borers in infested and dead trees of *Q. leucotrichophora* and *Q. dilatata* in the oak stands with borer attack (sites 1, 2 and 3). These species were, Himalayan Woodpecker, *Dendrocopos himalayensis*; Brown-fronted Woodpecker, *Dendrocopos auriceps*; Scaly-bellied Woodpecker, *Picus squamatus* and Greater Yellownape, *Picus flavinucha.* These species were most active on oak trees during winter when the borers grubs hibernate.

Biotic interferences

Biotic interferences recorded in *Q. leucotrichophora* stands were mainly in the form of extensive and repeated lopping of oak trees and grazing by cattle (sheep, goats, buffaloes, cows and horses) belonging to the local villagers and migratory 'van gujjars' during summer in Deoban Reserve Forest and in Dangan and Duni villages in Govind Wildlife Sanctuary. Extensive lopping is one of the major causes of borer incidence as the wounds on lopped branches attract ovi-position by primary borers like *Aphrodisium hardiwickianun* and *Rosalia laterifolia* (Beeson,1941 and Khan and Bhatia, 1946). It was established that the borer infested sites (1 and 2) were those which had both higher number of lopped trees and/or witnessed heavy grazing. Rank correlation between the percentage of borer infestation in oak stands and their respective incidence of lopping (classes 1-4; table 1), revealed a strong positive relationship between the two ($r = 0.9061$; $p = 0.01$).

Management Options

Prohibition on lopping of oak trees in badly borer infested oak stands will help in checking the further spread of the borer infestation besides burning of oak

Table 1

Extent of damage by borers on different species of west Himalayan oaks in Uttarakhand

S. No.	Site	Forest status	Oak species	Altitudinal Range (msl)	Percentage infestation of oak s	Oak Tree density/ha	GBH range & mean (m)	Lopping in stands/class	Grazing
1	Dangan village-Haltari Blocks 1A&B in Supin range &	Wildlife Sanctuary -Village Forest/	Ban	1800-1850	23%-Ban	1450/ha-Ban	0.51-1.22; 0.78-Ban	>75%=4	Heavy
			Moru	1950-2000	26.8%-Moru	1050/ha-Moru	0.41-2.40; 1.03-Moru	>75%=4	Heavy
	Duni village-Rupin range (Uttarkashi district)	(Agriculture/ Horticulture)	Ban	1900-2000	19%-Ban	560/ha-Ban	0.45-1.35; 0.82-Ban	>75%=4	Heavy
2	Chakarata-Deoban (6/9A/9B)- (Dehradun District)	Reserve Forest	Ban,	2200-2250	9%-Ban	1200/ha-Ban	0.46-1.60; 0.74-Ban	<25%=1	Moderate
			Moru	2400-2600	22%- Moru	1850/ha-Moru	0.25-2.10; 0.79-Moru	>50%=3	Heavy
			Kharsu	2500-2740	28%-Kharsu	1105/ha-Kharsu	0.21-1.45; 0.73-Kharsu	>50%=3	Heavy
3	Benog WL Sanctuary-Mussoorie (Dehradun District)	Wildlife Sanctuary	Ban	1800-2100	1.0 %-Ban	970/ha-Ban	0.35-1.72; 0.79-Ban	<25%=1	Low
4	Kanatal- (Tehri Garhwal district)	Reserved Forest	Ban	2100-2327	34.4%-Ban (dead but with no sign of borer infestation	1100/ha-Ban	0.45-3.00; 1.10-Ban	<25%=1	Moderate
5	Mandal-Kanchula Kharak-	Wildlife	Ban	1400-1700	Nil-Banj	–	–	<25%=1	Low
	Kedarnath Sanctuary-	Sanctuary	Moru	1700-2500	Nil-Moru	–	–	<25%=1	Low
	(Chamoli dist)		Kharsu	2500-3100	Nil-Kharsu	–	–	<25%=1	Low
6	Adwani-Kandolya - (Pauri District)	Reserve Forest	Ban	1900-2000	Nil-Ban	–	–	<25%=1	Low

slash, removing of dead infested trees and logs from the infested sites. Infested and treated trees should be marked and monitored for the spread of infestation. Since lack of fodder tree species in the area is one of the major cause of damage to oak tree, intervention by planting fodder trees and grasses in fringe of villages may also be considered. Also, awareness may be generated amongst the villagers about damage being caused by lopping to valuable oak trees which play a vital role in the Himalayan ecology.

For management of oak stem borers, chemical treatment should be given using systemic insecticides 'monocrotophos' (36 EC) or 'dimethoate' (30 EC) (0.02-0.04 %) as tree injections (Bhandari *et al.*, 2003) or application of a fumigant eg. saturated solution of 'para-di-chlorobenzene' in kerosene oil @ 5-10 ml/ lowest ejection hole on the trunk (Singh *et al.*, 2004) and then plugging the ejection holes with clay or stones, during post monsoon season. The reduction in borer infestation and beetle mortality in treated trees relation to control trees (infested trees without treatment) can be assessed in next summer when emergence of beetles takes place from the emergence holes. At this time beetles will be found dead in the larval galleries that can be checked by removing the plugs.

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SUMMARY

The complex interaction of environmental stress, poor natural regeneration and insect pests have lead to oak forest decline in himalayan sub-region. Amongst the insects, stem and wood boring beetles are capable of causing significant oak mortality. The paper reports the outcome of surveys on wood boring beetles carried out in moist temperate oak forests mainly with Ban oak, *Quercus leucotrichophora* Camus, Moru oak,*Q. dilatata* Lindl and *Q. semicarpifolia* Smith in six sites in the Garhwal region of Uttarakand, India. Amongst the two primary Cerambycid wood borers, *Aphrodisium hardwickianum* White was prominent on *Q. Leucotrichophora* in disturbed forest tracts in Dehradun (Benog Sanctuary)and Uttarakashi district (Govind Wildlife Sanctuary), (Kannatal) Tehri Garhwal district with infestation in stands ranging from 1 to 34.4 per cent. Another longicorn beetle, *Rosalia laterifolia* Hope preferred *Q.dilatata* mainly in Deoban Reserve Forest Chakarata Forest Division in Dehradun district causing 28 per cent tree mortality. 12 species of secondary wood boring beetles were also collected from these 6 sites along with two species of insect natural enemies and four species of Woodpeckers. Management options both silvicultural and chemical control, are given.

Key words: Cerambycidae, woodpeckers, Elatridae, Braconidae, Picidae, Monocrotphos, Dimethoate, lopping, grazing, fodder, fuel wood, Protected Areas, Tree density, NFRIC-Dehradun.

गढ़वाल के हिमालयी भूभाग भारत में बांज छिद्रकों का आयात और बांज वृक्षों का मरण

अरूण पी. सिंह

सारांश

पर्यावरण से पड़ते दबाव की जटिल अन्तर्क्रिया कम प्राकृतिक पुनर्जनन और नाशिकीटों के संघात से ही हिमालयी उप भूभाग में बांज वनों में कमी आई है। कीड़ों में तने और लकड़ी में छिद्रण करते भृंग काफी ज्यादा बांज वृक्षों का भरण करते हैं। इस अभिपत्र में आर्द्र समशीतोष्ण बांज वनों में किए गए काष्ट छिद्रक भृंगों का सर्वेक्षण सूचित किया गया है जिनमें प्रधानत: वन बांज (*क्वेरकस ल्यूकोट्राइकाफोरा*) कामुस, मोरू बांज *क्यू डायलेटाटा* लिंड्ल और *क्यू सेमिक्रायोफोलिया* स्मिथ ही उत्तराखण्ड के हिमालयी भूभाग के छह स्थानों से होते पाए जाते हैं। दो मुख्य सेराम्बाइसिड काष्ठ छिद्रकों में *एफोडिसियम हार्डविकियानम,* देहरादून के विक्षुब्ध वन खण्डों, बेनोग अभ्यारण्य, जिला उत्तरकाशी, (गोविन्द वन्यप्राणी अभ्यारण्य) (कन्नाताल) टिहरी गढ़वाल में *क्यू ल्यूफोट्राइकोफेरा* पर लगता पाया जहां इसका आयात 1 से 34.4x तक था। एक अन्य लॉगीकोर्न भृंग, *रोजेलिया लेटरीओलिया* होप को मुख्यतया देवबन आरक्षित वन चकरौता वन मण्डल, देहरादून जिले में *क्यू डायलेटाटा* पसन्द आया जहां के वनों में इसका आयात होने के कारण 28x वृक्ष मर गए। गौण या द्वितीयक काष्ठ छिद्रक भृंगों को भी इन छह स्थलों से संग्रहीत किया गया जिसमें से दो कीट जातियां, प्राकृतिक शत्रु जातियां है तथा चार काष्ठ में चिह्न बनाने वाली। इनका प्रबन्ध करने के लिए वन संवर्धन और रासायनिक दोनों नियंत्रण उपाय बताए गए हैं।

References

Beeson, C. F. C. (1941). *The ecology and control of forest insects of India and neighbouring countries.* Govt. of India Publication, 110-111; 682-683 pp.

Bhandari, R. S., J. M. S. Rawat, V. Kumar and S. M. H. Zaidi (2003). Chemical control of coneworm, *Diroyctria abietella* Denis and Schiffermueller (Lepidoptera: Pyralidae) in seed production areas of Deodar (*Cedrus deodara*).*Indian Forester,* 129 (9): 1141-1146.

Browne, F. G. (1968). *Pests and Diseases of Plantation Trees*. Clarendon Press, Oxford. 130 pp.

Gardner, J. C. M. (1927). Immature stages of Indian Cermabycidae. *Indian Forest Rec.*, 13 (2): 1-31.

Khan, A. H. and B. M. Bhatia (1946). *Aphrodisium hardiwickiabnum* White (a borer of *Quercus incana*) and its control. *Indian Forester*, *72* (6): 271-272.

Mathur R. N. and B. Singh (1959). *A list of insect pests of forest plants in India and adjacent countries.* –Part-8-List of insect pests of plant genera 'P' to 'R' (*Paederia* to *Rumex*). Govt. of India Press, Faridabad, Delhi.130 pp.

Rawat, P. S., J. M. S. Rawat and S. Chandra (2003). A report on the mortality of oak in Dangan Gaon, Mori Block, Uttarkashi (Uttaranchal).*Indian Forester,* 129 (3): 418-420.

Singh, A. P., R. S. Bhandari and T. D. Verma (2004). Important insect pests of poplars in agroforestry and strategies for their management in northwestern India. *Agroforestry Systems,* 63: 15-26.

Wargo, P. M.., R. D. Houseton and A. L. laMadeleine (1983). Oak decline. *Forest insect and disease leaflet* No. 165. U.S. Department of Agriculture, Forest Service.