The Politics of Fire and Forest Regeneration in Colonial Bengal

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SUMMARY

This paper contends that recent scholarly interest in systems of colonising knowledge, whether called 'scientific forestry' or 'development', has paid inadequate attention to the historical processes shaping such knowledge production in specific colonial locations. Taking a processual approach, the paper examines the conflicted constitution of scientific forestry in India through regionally varied experiences of forest management in Bengal sal (*Shorea robusta*) forests. The case of fire, and disputes surrounding its perceived role in forest regeneration across eastern India, is used to understand and demonstrate the complex mutually transformative linkages between social categories like nature, culture, history and power.

Soon after the introduction of forest conservancy in Bengal during 1864, colonial foresters had their first notable success with fire protection. Colonel Pearson, aided by two years of heavy monsoon rains, had protected the Bori forests of the Central Provinces from annual fires in 1865. Over the next decade, exclusion of fire from reserved and other categories of forests where conservancy was introduced, became emblematic of what care and modern management could accomplish in the forests of India. By attempting to banish fire from the landscape, European forestry distinguished modern forest management from the primitive techniques it claimed to supersede. The idea derived from similar contrasts through which agriculture had been transformed earlier in Europe.[1] By the 1870s, when forest policy was framed and institutionalised in various parts of India, it certainly drew on such a language of improvement, casting colonialism's project in terms of reclamation – of both colonised peoples and lands. In 1875 the *Indian Forester* was established by the Bengal Conservator, William

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Schlich, as the flagship journal of scientific forestry. The very next year, Baden-Powell, one of the architects of colonial forest policy wrote in its pages, 'it is possible that the progress of knowledge has driven out this idea to a great extent in India, but there are here and there some few who still argue for forest fires, just as in England some eccentric individuals occasionally question the fact that the earth is round'.[2]

Certitude of this sort illustrates the confidence of imperial science. An assurance resting not only on what Whiggish notions of history predisposed British colonial administrators to think, but also on their reading of nature in the colonies.[3] These representations shifted swiftly across the diverse terrain of Bengal, cataloguing its non-agricultural resources and despairing at their mismanagement. The possible autochthonous remedies to these perceived problems or the probability of such a view of unredeemed natural destruction by 'native' society being a misrepresentation, remained undiscovered. Political and ecological order then could only follow from the application of external controls and foreign expertise. Given these predilections, fire in the Indian forests was firmly lodged in the colonial imagination as something rampant, random and reprehensible.[4] Yet, in the next fifty years, as British foresters in Bengal turned their attention to intensive forest management and regeneration of desired species, specially sal (*Shorea robusta*), they ruefully discovered that fire protection had created a situation 'which in the moister tracts weighs heavily against the very species it was designed to assist'.[5] This remark summed up the lessons of growing evidence flowing from various sal bearing regions of eastern and northern India, following a discovery made in Bengal two decades before these words were written. An itinerant expert had already drawn attention to the awkward conflict between prevailing scientific wisdom and the 'realities of nature' in sal areas across eastern India, saying, 'anyone who considers the use of fire a breach of the laws of sylviculture need only see the excellent condition of a forest continually burnt ... where you find all ages represented by different groups of sal ... no creepers and remarkably rich patches of regeneration where you have an opening'.[6]

This story will support many tellings. Our narrative could recount how imperial science was destabilised. But more importantly, the case of fire and forest regeneration, so well illustrated by the struggles over sal regeneration in Bengal, provokes a re-examination of the processes through which colonial science was constituted. What was its relationship to imperial expertise? What does it show about the entanglements of knowledge and power? Did nature itself, or local politics or regional history or imperial design most definitively shape forest management in Bengal? How do we refine our understanding of scientific forestry in India? For it remains, as colonial legacy and post-colonial development programme, salient to the politics of environmental management today. These are the organising impulses for what follows.

Clearly colonial science was about a style of imagining the world, a regime of representations. We have to focus, however, not merely on the content of these representations, but 'on the process of their composition and deployment'.[7] In what was the first systematic discussion of scientific forestry, this process appears to be the subject of study for Ramachandra Guha, who shows the adaptation of colonial forest management in Uttarakhand to historical contexts of peasant resistance. But he does conclude 'both legislation and silvicultural technique were designed to facilitate social control'.[8] This allows for no discordance between politics and science, nor does it explicate the nature of social control and the constant shifting of mechanisms. In this mode of analysis, colonial forest science is a received version of European models that is then subordinated to economic imperatives. Writing on the work of the Imperial Institute, Michael Worboys comes to a similar conclusion. In his account it is only in the 1920s that the decline of the Institute signals emerging independent, scientific infrastructure in India and the Dominions.[9] Recently, other historians of colonial science have questioned such simplification. Challenging this perspective of Worboys, which also informs his work on malnutrition and diet, David Arnold asks, 'is it appropriate to look to metropolitan direction and design in the fashioning of colonial science or should we look instead to local processes of investigation and analysis?'[10] He goes on to demonstrate that between 1860 and 1914 famines and jails provided important contexts in India for widening nutritional knowledge and debate.

Similar controversy over centralist and peripheralist historiography of colonial science has broken out in other branches, notably the history of colonial geology in India.[11] For imperial historians empire was a captive laboratory for British geology, thus perpetuating a division of labour between metropolitan theorisers and provincial fact gatherers.[12] Stafford joins other historians of the Victorian era of exploration and biogeography in proposing a congruent efflorescence in geographic sciences, maritime and colonising traditions, where the goals of science were commensurable with the civilising mission.[13] After all, Darwin, Forbes, T.H. Huxley and J.D. Hooker had all sailed on Royal Navy hydrographic expeditions, and 'obvious parallels exist between the belief of these scientists in the dominance of northern life forms and their faith in England's manifest destiny as an imperial power'.[14] That said, while we may be closer to understanding parts of the imperial imagination, we remain far from explaining the processes in which it was formed. Mackenzie draws our attention to this issue astutely when he points out that the nineteenth century was a period when amateurs dominated science.[15] So drawing sharp distinctions between doers and receivers may be problematic. It may misrecognise the process of scientific discovery, ignore failures and false moves in transfer of metropolitan science to the colonial province, and omit noting the conditions that empire often uniquely offered for scientific discoveries. In short, there is an interactive and contextualised production of knowledge that needs to be understood.

The history of natural science illuminates the interaction of imperial and indigenous ideas,[16] and the role of colonial experts, from forest guards to field foresters, in shaping this interaction. Evidently their expertise combined formal ideas and substantive local knowledge and after a point trying to separate the two becomes an exercise in reification that provides no insight.[17] What do we lose sight of? First, as Sangwan perceptively points out, whether favouring local initiative or central fiat in explaining the conduct of colonial science, the debates referred to earlier and the 'two systems approach' share the common failing of treating the scientific establishment as a monolith that is a puppet either of ideologies of empire or colonial exploitative arrangements – science a tool of revenue generation. He says, 'they ignore the internal culture of the corps d'elite, especially the making of a scientific discipline with its historical transition from amateurism to a professional form of activity'.[18] Providing a welcome look at the absorption of indigenous knowledge in particular domains of science, and how local officials sought independence from metropolitan control, Sangwan notes further, 'though the colonial state pressed for a profit oriented scientific agenda, the scientific part was never completely set aside'.[19] In the same vein, Richard Grove has long emphasised the role of colonial naturalists and surgeons in developing a discourse of environmental degradation in early nineteenth century India. Mahesh Rangarajan has added by suggesting ways to comprehend the connections between conservationist ideas and specific policy changes in the early history of colonial forestry in India.[20] In other new work, Grove has emphatically argued that research done by botanists and medical specialists under the auspices of the East India Company facilities was important to establishing the relationship between global climate, drought, monsoons, hurricanes and the El Niño and Southern Oscillation (ENSO).[21]

It is further suggestible that tree planting and forest conservation began in the early nineteenth century based on such climatological knowledge in the hands of people like William Roxburgh, who was the Director of the Calcutta Botanical Gardens. Grove argues, 'science in the periphery, especially India and Australia, lay at the cutting edge of new knowledge and theorisation'. The famine of 1877-79 promoted a lot of work on the relationship between deforestation and rainfall under Edward Balfour, Surgeon General, and the Inspector General of Forests.[22] This resulted in prolonged controversy between different branches and levels of the colonial Indian government. When the research was given up in the early decades of the twentieth century, it had already contributed to a contentious and unsuccessful attempt to intervene in private forests in Bengal. A highly systematised and polarised view of western and local knowledge in the making of colonial science can underestimate the productive forces unleashed by discord and conflict within colonial bureaucracies.

Secondly, by separating the production of knowledge from the processes of state-making in which it is embedded, the complex interlocking of governance issues with forms of knowledge and representation can be overlooked. Mary

Louise Pratt has reminded us that discoveries made in colonies often 'consisted of a gesture of converting local knowledges into European national and continental knowledges associated with European forms and relations of power'.[23] What passes for local or modern scientific knowledge bears marks of such appropriation and counter-appropriation in specific colonial contexts. In an intriguing history of the management of air pollution in Calcutta through the nineteenth century, Michael Anderson has shown how the definition and regulation of smoke nuisances was peculiar to the colonial context of Calcutta as the seat of Indian empire. In addition to the valuable insight that 'many features that are now axiomatic in environmental regulation – systematic monitoring, reliance on technical experts, technological remedies, and close collusion between industry and bureaucracy – were consolidated under the aegis of the Smoke Nuisance Act', Anderson illustrates how the conquest of smoke was uniquely a colonial enterprise.[24] This important work of Anderson vindicates the pursuit of genealogies and reveals the fascinating linkages between scientific discourse and state formation. My discussion of scientific forestry in Bengal similarly attends to the production of colonial science and locates it in the regional history of state-making. Exploring the connections between scientific ideas and pragmatic approaches, this essay delineates the articulation of science and imperial power, to show 'the influence of scientific misconceptions on the practise of imperial rule'.[25] Following David Ludden's discussion, I examine this composite process as the making of a development regime for sal forest management in Bengal.[26]

This essay is also necessarily about the interplay of patterns in nature and schemes of representation. The following examination of sal silviculture adumbrates the need to consider nature as 'a lively if socially constructed actor'.[27] By 1905, making the first revision in the forest working plans for Jalpaiguri Division, in the Bengal Duars, Trafford, the local forest officer, remarked upon the difficulty he faced in classifying the landscape into vegetation types. Vexed in particular by the mixed forest and savannah areas identified in the previous plan, he said, 'these types not only merge into one another but are constantly changing and a stock map is constantly getting out of date'.[28] In the next thirty years issues of classification gave way to the struggle over forest regeneration, reflecting a worldwide transition in the status and directions of ecological research and knowledge.[29] As Indian foresters grappled with sal regeneration, earlier forest classifications were revisited and altered and forests were redefined to incorporate freshly gained awareness of ecological dynamics within them.[30] As a luminary of sal silviculture research from the period put it, 'the idea that a sal forest may be transient and in the time space continuum may fade away as a morning mist, will probably come as a shock to many foresters'.[31]

Such impermanence in the landscape bore no simple explanation. Ecological processes and political inaction fused to produce it in North Bengal, something we shall examine in detail later in this essay. At this point, I will merely anticipate

and highlight the argument by pointing to the inadequacy of recent theorising in cultural geography and environmental history for apprehending the vicissitudes of sal regeneration in Bengal and its historical construction in the corpus of scientific forestry. Cultural geography's emphasis on representations, especially the inherent instability of meaning is often taken to the point of making nature epiphenomenal or passive, a text, spectacle, icon or theatrical production.[32] An analysis that demonstrates a clash of representations and interests, however the groups engaged in such conflict are defined, reproduces this tendency noted in cultural geography. Both in India and elsewhere, studies of forest management and resistance, though varying in their deployment of cultural analysis, have shared this neglect of ecological processes.[33] At the same time, we have to remain wary of environmental history's innate biocentrism whether it takes the form of Worster's homeostatic nature; Merchant's nested model of ecology, production, reproduction and consciousness; or Cronon's sophisticated analysis of 'first nature' and 'second nature'.[34] All these exemplars of environmental history assume at some point that nature simply is. My analysis, in contrast, wishes at no stage to disable 'consideration of the processes by which what passes for nature is actually determined'.[35]

The first thirty years of forest conservancy in Bengal were the period of conservative lumbering. Physical control of forested land, assured supply of timber, and profits in forest operations were driving concerns of forest management. In 1899, the Lieutenant Governor of Bengal had deprecated the decline in revenues from forestry saying, 'forest officers must realise more than they do that they are the agents of a great commercial undertaking … and as such they are not merely the scientific protectors of an important property'. Active exploitation of forests to the limit of possible annual yield was the professed goal.[36] Within the next decade the priorities of the government were being radically reformulated, and primacy was being given to regeneration. This concern with regeneration voiced an older anxiety about desiccation, namely the relationship of forest to rainfall, surface hydrology, drought and floods; but it also arose from the newer discoveries about difficulties in sal reproduction in reserved forests.[37] Scientific forestry as a regionally specific set of practices emerged from this policy transition. Silviculture was introduced as a major departmental activity by 1908, requiring detailed annual reporting. But hopes remained pinned on natural regeneration of sal in all provinces of Bengal.[38] So the movement from restrictions to regeneration flowed along existing channels.

At the time of demarcation and protection, grazing, fire, shifting cultivation and the collection of firewood rapidly became stock items on the standard list of ills to be curbed.[39] At one exalted level of analysis, forest fires 'as the concomitants of both the nomad and the backwoods cultivator', represented to senior foresters aggravating demands on forests from a primitive state of society, less legitimate than those made by 'rapidly spreading modern civilization'.[40] More immediately, during this phase, freedom from cutting and immunity from fires

were central to the plans Brandis made for forest management in all provinces including Bengal.[41] The rationalisation of jungles (signifying wastes and wildlands) was part of a wider impulse to reform and manage the productive landscape. To politics British foresters added 'the symbolism of science'. To justify fire control they drew upon European agronomy where the divide between primitive and modern was fire.[42] As the noted historian of forests and fire observes, 'what emerged was a robust exemplar, an adaptation of European techniques to exotic woodlands and colonial politics'.[43] In his review of 1884, the successor to Brandis as Inspector General of Forests, William Schlich, wrote, 'owing to the vast extent of the Indian forests and high cost of artificial operations, the natural system of reproduction must be chiefly relied on, that is to say forests must be properly protected, fires kept out ... areas closed to grazing'.[44]

Year	Reserved and other forests	Fire protected forests	percent excluded/failure
1878-1879	3,474	2,938	15
1879-1880	4,072	3,709	9
1880-1881	4,465	4,194	6
1881-1882	4,897	4,283	13
1882-1883	4,826	4,562	5

TABLE 5.1. Fire protection in Bengal Presidency (area in square miles)

Source: Adapted from William Schlich, 'Review of Forest Administration for British India,' p. 376.

In Bengal, in the first flush of forest reservation almost everything was closed to firing. By 1900 the area under reservation had increased to 5880 square miles, and the total managed area (including protected and unclassed forests) was up to 13,589 square miles in Bengal. This period also marked the beginnings of more scientific operations as the task of preparing working plans was taken up.[45] Each of these features of scientific forestry merits consideration in detail, especially since they are best understood through their inter-relationships.[46] Here only the case of fire is discussed, tracing the attempts to accomplish fire protection in Bengal forests. While southwest Bengal became the region where fire policies foundered on poor implementation, they were embarrassingly successful in the northern parts of Bengal, only to be confounded in their objects

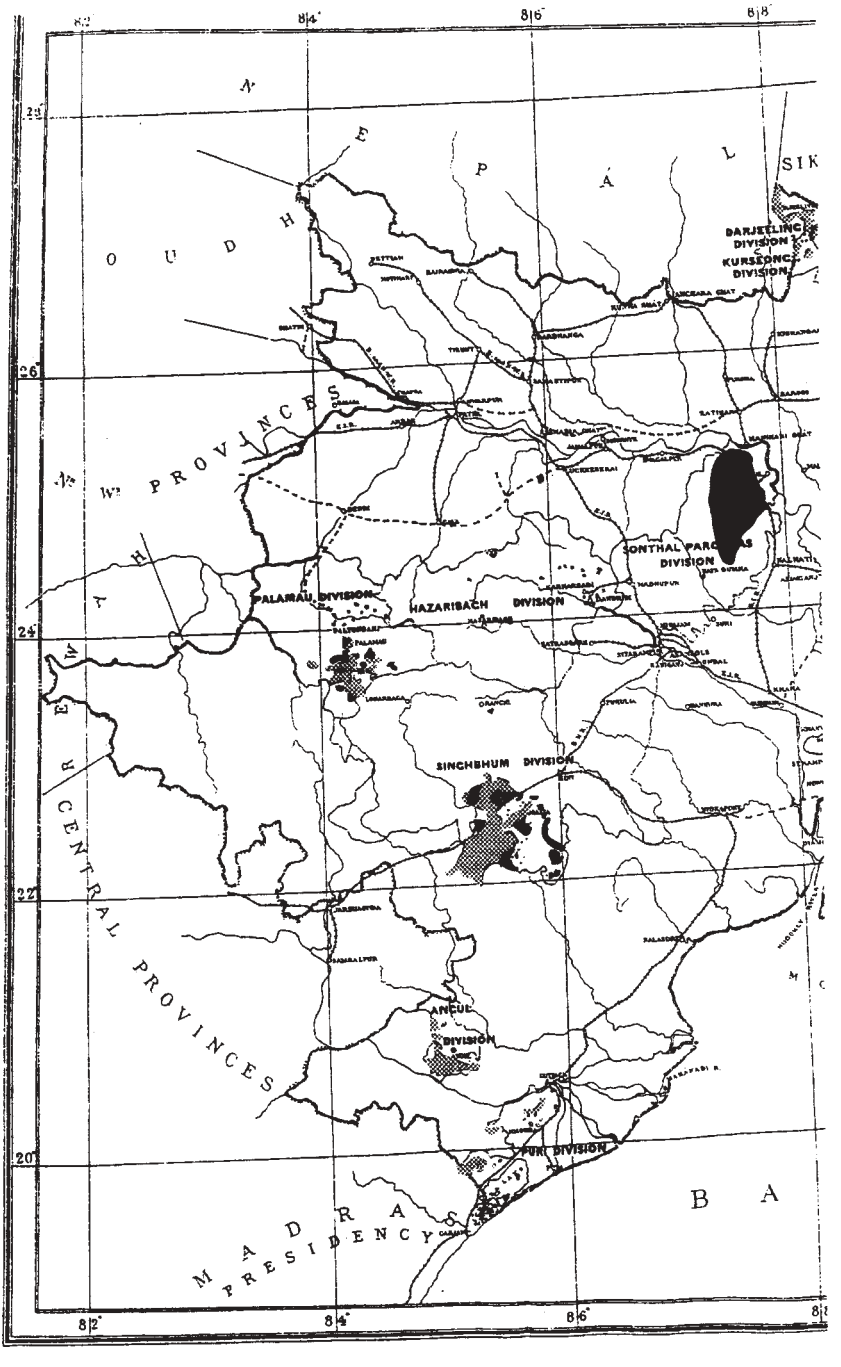
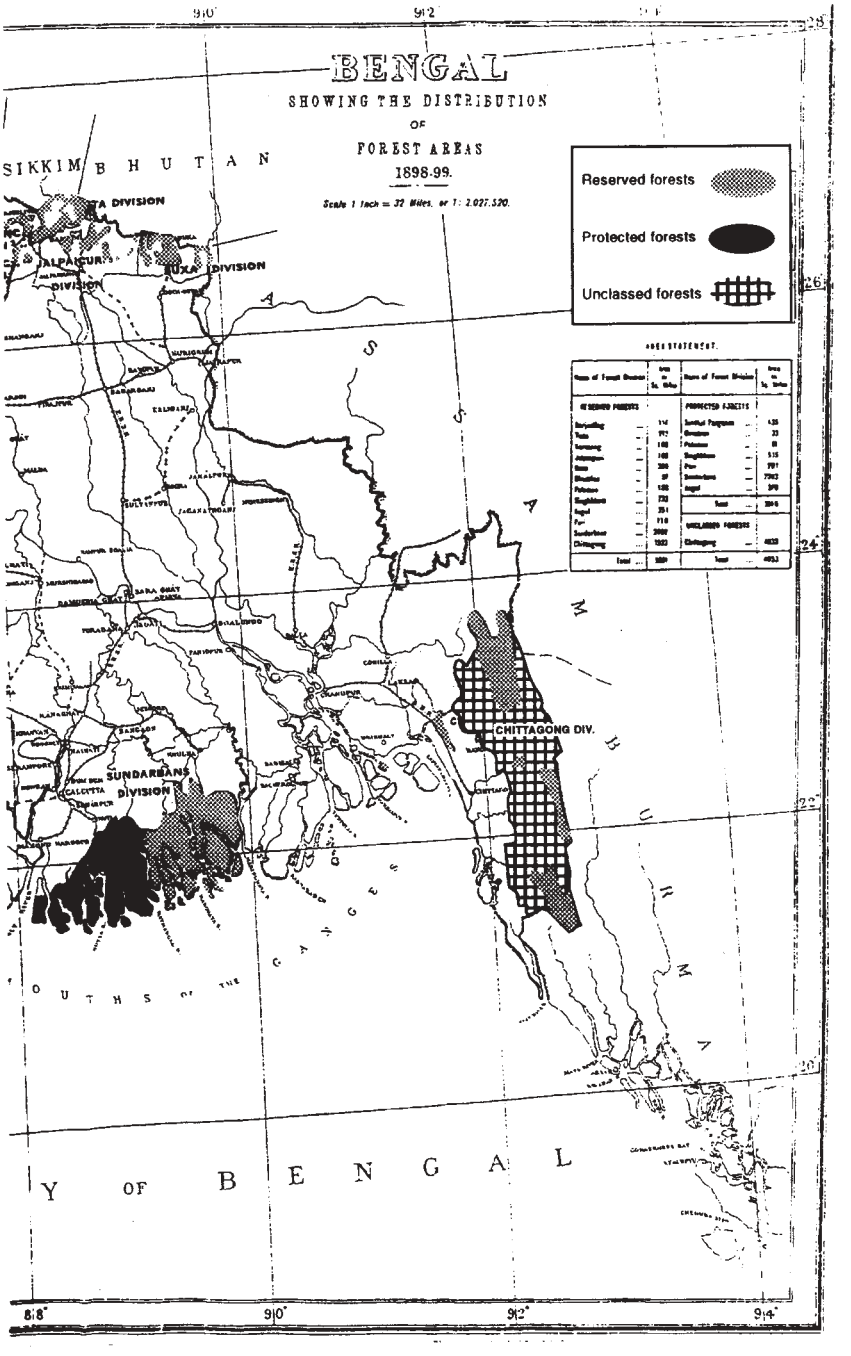


FIGURE 1. The Forest Areas of Bengal 1898



Based on: *Bengal Forest Administration Report, 1898-99.* Calcutta: Bengal secretariat Press, 1900. Reproduced by permission of the Syndics of Cambridge University Library.

by this very fulfilment. The critique of fire exclusion from forest regeneration emerged from the confluence of these experiences, producing a range of strategies – both silvicultural and political – by which fire was incorporated in forest management. Distinguished both by regional political economy and agro-ecological characteristics, this north south divide entered and shaped the classification of Bengal sal forests as dry (mostly southwestern) and moist (mostly northern). So before moving to the details of fire and sal forest regeneration in Bengal, the distribution and characteristics of sal in Bengal are briefly sketched out, for this tree came to dominate the attention of scientific forestry in Bengal.[47]

Sal, one of the most important timber trees of India, formed extensive forests along the foot of the Himalaya and in the eastern part of central India.[48] Sal occurs in all Bengal forests except the Sundarbans, and Darjeeling areas above 3000 feet. The favourable localities are those with deep soils, receiving 60-200 inches of annual rainfall, like Kurseong, Duars, Teesta Valley, Singhbhum.[49] The moist sal zone, with a normal rainfall exceeding 75 inches annually, extends into lower Bengal, Sylhet, Assam Darjeeling and Duars.[50] The sal depends to a much greater extent than teak on the peculiarities of soil, being found mostly on sandstone conglomerate and gravel, not thriving on heavy clay soils that are poorly drained.[51] Both edaphic conditions and extensive forest use prior to British interest presented a landscape where sal was scattered in small blocks amidst savannah and jungle. In 1870 Capt. Losack had surveyed and reported on the forests of Chota Nagpur, particularly to ascertain the extent and condition of timber quality sal. The forests he found were the product of extensive and long-term *jhumming*, where sal was mixed with a large number of associates.[52] The previous year reports on the east Bengal Duars forests had also noted valuable sal tracts in poor state of preservation.[53]

Sal is endemic to Bengal, its home being northeastern India. In descriptions emerging from the detailed surveys done while preparing working plans, North Bengal sal is often mentioned as the finest anywhere in India.[54] Sal, like most dipterocarps, is characterised by tall straight cylindrical boles without branches for a considerable distance from the ground. It is capable of withstanding periodic desiccation and is well adapted to life in a monsoon climates. Sal provides hard timber possessed of good structural qualities.[55] According to Troup sal is borderline between evergreen and deciduous, approaching the former state in moist, fertile localities and the latter in poor, dry ones. But according to Rajkhowa the two formations of deciduous and evergreen sal appear to be more determined by length of the dry period rather than annual rainfall, which means that this characteristic is much more dependant on biotic influences and less on abiotic factors.[56]

Leaf fall occurs at the end of the cold season, flowering early in the hot season, fruit fall at the end of the hot season. Germination occurs with the

monsoon, and the seed is short lived. So in dry areas, timely rains become important to ensure a good amount of natural regeneration. Some seed is produced every year, though there are definite mast years. Fruit are buoyant in water and dispersal of seed by water does happen. Growth is chiefly during the hot season, when new leaves appear, ceasing entirely by the end of the hot season. Being xerophilous, hardy and an abundant seed producer, sal is gregarious. The bark is deeply furrowed. Since sal is light demanding for the establishment of seedlings, young growth tends to happen in even-aged patches of gaps where sufficient light is admitted. Sal localities are characterised by various forest grasses which are important to the economy of the crop. These grasses often form extensive savannah tracts within the forest, and if well drained (hydrologically speaking), the trees spread to the grasslands. While grass increases the incidence of fire, sal's being resistant to fire after bark formation, gives it a competitive edge over less fire resistant trees. Up to a moderate size sal coppices well, giving out several stool shoots from the base of the stump. Die-back of seedlings under adverse conditions is an important adaptive mechanism. This is discussed a little more later.

Northern Bengal, including Darjeeling, Jalpaiguri, Cooch Behar, British Sikkim and Bhutan comprised the distinct ecological zone of moist sal. The Himalayan foothills are further subdivided into the *terai*, west of the Tista river, which was poorly drained; and the *bhabhar*, east of the Tista, also known as the *Duars*, which was well drained, this hydrological distinction distinguishing otherwise similar alluvial soils that were frequently sandy loams rich in humus.[57] Fairly uniform geology, tertiary alluvial deposits ascended through terai, bhabhar and foothills into the Himalayas. Soil textures of terai tend to be finer than bhabhar. Sal, not liking swampy conditions very much, is confined to dry ridges and southern aspects of the *terai*, where some of the best sal in India is found.[58] The terai is patterned with a network of springs, rivulets and *nullahs* (ditches) that reveal moisture at the surface due to the slow movement of moisture through the soil. The grass *Microstegium ciliatum* exists in bhabhar but not in the terai. Early *taungya* work was done in the terai sal forests where regeneration with fire protection was found impossible.[59] As we shall see in the subsequent discussion of sal regeneration in North Bengal, most of the sal forest of the terai and bhabhar tracts of Bengal came out of savannahs through periodic burning and shifting cultivation.[60] On fire protection in the savannah *Macaranga* may come in as the first stage of a woodland succession of which sal was the final stage. Alternately, sal seedlings from existing groups may directly colonise the grassland.

The other important distinct sal zone in Bengal was that of dry sal. Classified as dry peninsular sal, these forests occurred in areas of dry hilly country, hard ground and shallow soils with a mean annual rainfall below 60 inches but above 35 inches.[61] This occurred mostly in the laterite belt along the boundary with Bihar, contiguous with the Chota Nagpur plateau that loses elevation to the east of Bihar and Orissa, where the spurs dip down to the plains of Bengal. An

outstanding characteristic of this dipping table land is the extensive exposure of laterite. The geology is somewhat varied, hills are often gneissic but soils lateritic, with sal doing well where the laterite is decomposing.[62] Sal is not averse to ferruginous soil but avoids calcareous sub-zones. The area is highly eroded and the exposed soil is yellow-grey on top, and red below. Organic matter, nitrogen, available phosphorus and calcium are low, leaving the soils with a slightly acidic pH. These areas also have some red sandy soils. These forests were felled repeatedly in the nineteenth and twentieth century, being thus of wholly coppice origin.[63] Some occasional specimens of good trees in local *devasthans* indicate the limited protection of sal. Sal has also been reported to invade abandoned mango gardens adjacent to forests in south Bengal. This invasion was frequently in the shade of *Madhuca longifolia* and *Ficus* spp.[64] According to a report prepared in 1939 on Bengal forests, 70 percent of the dry sal forests of Midnapore were worked on a rotation of six years. With the passage of the Bengal Private Forests Act, 1948, the sporadic attention paid by jungle *zamindars* (landlords) to sal regeneration was subject to working plans. Artificial regeneration of sal was taken up in Midnapore, but without much success.[65] In 1956, the forest department took the forests over and found that due to repeated fellings the sal areas were greatly depleted, leaving *Diospyros melanoxylon* and *Madhuca latifolia*.[66]

In these dry peninsular sal regions of southwest Bengal, during the 1970s and 1980s, eucalyptus plantations were attempted, with social and ecological repercussions that provide the immediate history to Joint Forest Management (JFM). JFM has emerged as a vehicle for revived interest in natural regeneration of endemic species, notably sal, in the 1990s. But the critique of eucalyptus and other planted non-local trees that has formed part of the impetus toward the altered silvicultural agenda in JFM areas, was anticipated eighty years ago. Hole, the leading ecologist in the colonial forestry establishment, deprecated the widespread planting of *Eucalyptus globulus* even in localities unsuited to it. He suggested that the silvicultural program of the forest department, must accept 'species as they exist in nature … and provide … conditions of soil, moisture, climate and light which suit it best'.[67] People like Schlich and Hole were instrumental in diverting energies in Indian forestry away from large-scale plantation activities to natural regeneration of sal, teak, *sissoo* and *khair* in the submontane and peninsular regions of eastern, northern and central India.[68]

Thus one of the major concerns of Indian silviculture, as it developed through the first decades of the twentieth century was securing the natural regeneration of valuable timber species, which in eastern India were principally sal and teak.[69] Some niche partitioning between the two species does seem to occur given their different preferences for soil moisture regimes. Sal not liking high residence times for soil water, avoids lowlands, hollows, plains and seeks highlands, hill slopes. These are typically areas with nutrient poor, deep soils, excessively

drained and high in sand content. Teak does better in mesic valley bottoms, needing greater soil fertility and moisture, which is available in the clayey floodplains. Thus sal forests seem to be in regions historically home to the socially marginal, hill tribes, hunters, swiddeners and so on. None of these regions were free of anthropogenic disturbances, they were not virgin forests. As Brandis puts it, 'in the wildest forest regions of India we constantly come across evidence that the land at one time had been under cultivation – fruit trees, ruins of large buildings and terraces of old fields.[70] Old field sal forests less than two hundred years in age often contained old mango and tamarind trees, presenting evidence of receding cultivation due to pestilence, famine or raids by hill tribes.[71]

It would not be wrong then to conclude that in most of India woodland succession was less due to climate (temperature, precipitation) and more due to changes produced in growing conditions influencing moisture regimes, solar radiation, ambient ground temperature and soil physics, which were the result of river action, erosion, fire and grazing. Of these fire was the most ubiquitous. Recording observations from his Himalayan travels during 1847-51, Joseph Hooker described the plains of Bengal as immersed in smoke from fires in the terai forests.[72] Shebbeare, the Bengal Forester who did more than anybody else to incorporate fire into sal silviculture, recalled, 'every forest that would burn was burnt almost every year'.[73] Not surprisingly, in the sal forests of India, and for our purpose, North Bengal, some remarkable alterations were caused in the forest type by the introduction of fire protection in areas previously subjected to regular burning. Succession in these cases was often to forest types that were more hygrophilous.

But this takes us a little ahead of the unfolding events. Initially forest regeneration was seen as unproblematic, something that would naturally follow protection. So all forest management in Bengal and other comparable regions in India began with keeping biotic influences like fire and grazing out of identified forest tracts. Fire protection thus became a marker of forest conservancy as it was introduced, serving not only to distinguish state forests from others but exemplifying care and farsightedness in management. Lt. Michael of the 39th Madras Infantry made the first recorded attempt to protect Indian forests from injury by fire in the Annamalai teak forests. He had been appointed to set up forest conservancy in Coimbatore and Cochin in 1848.[74] A few years later, Brandis started work in Burma. He developed his ideas on fire protection in Pegu and Tenasserim in the 1853-1859 period where he increased teak yields by this method of regeneration. Writing later, Brandis recorded with pride, 'in 1862, I sent a few teak poles 30ft long to the great London exhibition, they had attained that height in two years, in a moist part of the country, on a rich soil and protected from fire'. [75]

In the 1865 hot season, Col Pearson first introduced fire protection in the Bori forest of Central Provinces. Fire protection then involved clearing fire lines and paths around the protected areas, early dry season burning of leaves and grass in

broad belt surrounding the forest.[76] Fire protection also consisted of clearing internal and external fire lines and sweeping them regularly, for which village headmen and *raiyats* provided free labour in exchange for privileges.[77] The earliest forest guards were primarily appointed for this purpose.[78] Faced with both a daunting task and one of dubious wisdom, these guards were among the earliest sceptics. They often burned forests surreptitiously, if only to improve the prospect of limited protection.[79] Sometimes, almost unwittingly, policy and practice coincided. Brandis, in his first tour of North Bengal forests in 1879 had recommended that savannah around forest areas be burned early in the season when the grasses are drier than the forests around them. He also envisioned a future of more complete fire protection where both savannah and forest would be protected to facilitate extending the forest margins into grasslands.[80]

The grass and dry leaves in the deciduous forests of sal, became inflammable in March-April when jungle fires regularly occurred. So fire protection began then. The longest serving Inspector General of Forests, writing at the turn of the century, gives an evocative description of the actual activities involved. 'The work begins fairly early in the season with the cutting of grass, herbs and bushes over miles upon miles of fire lines ... when this material is dry enough ... it has to be burned without causing damage to the neighbouring forests, chiefly at night when the dew has moistened the standing grass and when sparks can be more easily seen ... It is at night only that this work can be safely done ... soon the sky is red at night with grass fires and fires in private forests ... clouds of smoke wreath the horizon in the daytime.'[81] Such preventive fires and the ones the foresters viewed as purely destructive often burnt alongside. The latter transgressed the forest boundary, which the former sought to mark and preserve. Fire then prepared the ground for many things, but timber production was not seen as one of them. In one of his earliest discussions of forest fires in India, Brandis wrote, 'in majority of cases they arise from temporary clearings made by cutting and burning and the custom of herdsmen to burn down old grass in order to cause fresh tender shoots to spring up as fodder for their cattle'. He challenged the view that these fires may be beneficial and listed the damage. 'Millions of seeds and seedlings are destroyed, trees of all ages are injured, and often killed, the bark is scorched … dry rot sets in, the tree gets hollow and useless for timber. One of the most remarkable facts in the working of Indian forests in the plains and lower hills has been the large proportion of hollow and unsound trees. In many forests … the annual forest fires are the principal cause of this mischief.'[82]

The importance of fire protection, especially in North Bengal, also grew with the noticeable failure to establish plantations of exotics like mahogany, chestnut and teak. By 1876, Schlich the Conservator of Forests, Bengal, had started planting 100 foot sal belts in clearings around the Buxa reserve to protect it from fire. Curiously while fresh sowings of sal invariably failed, transplants from the forest did much better.[83] Brandis noted the reason in 1879, an outcome of forest fires. He recorded in his report, 'the vigor of these transplants is doubtless due

to the large knobs of wood which form the underground stem, the result of forest fires, which kill the annual shoots year after year, while the underground portion increases steadily in bulk'.[84] But during the early years of forest conservancy, the period discussed as that of conservative lumbering, such evidence and the reconstitution of scientific forestry that it might suggest was largely disregarded. Fire became an agent of deforestation through the reckless acts of nomadic tribes, the extension of cultivation and pasturage for all the nineteenth century colonial foresters and scientific professionals, like the geologist Valentine Ball.[85] Reporting on the first surveys of the newly acquired North Bengal forests, Anderson complained of frequent forest fires caused by shifting cultivation, revealing the ensuing struggle to establish forest department control in these areas by the restriction of firing. This was specially important as these forests in the Darjeeling terai were mainly young sal regeneration, for anything above six feet in girth had already been taken out by timber contractors.[86]

While fire protection as a measure of forest conservancy was introduced in Bengal as it had been in Central Provinces, the administration soon encountered various problems, since it interfered with the agrarian economy and lifestyles in a variety of ways. For instance *gwalas* (cowherds) used fire to secure fresh supplies of pasture grasses, while collective village fires in the early summer months were usually intended to facilitate the hunting of small game, foraging and gathering. In some upland tracts, wood from the forests was burned for manuring neighbouring fields.[87] In different parts of Bengal, fire would smoke out bees for honey, burn under *mahua* trees and other fruit trees to facilitate fruit gathering, burn back tall grasses in the proximity of hamlets to keep away tigers and panthers.[88] The Deputy Commissioner of Darrang, Major Graham and Major Lamb of Kamrup argued that forest fires helped clear land for cultivation, extirpate wild beasts and regenerate pastures. Another district officer pointed to the rank and dense undergrowth that comes up in a fire protected forest, fostering the multiplication of malarial parasites.[89] In one intriguing case, a forester reported that fire conservancy had increased the tiger menace since fires traced the routes taken by deer and tigers preying on them, thus indicating their place in the forest and making hunting easier.[90]

So objections to fire protection arose almost immediately after its introduction, but at this stage, in the 1870s, these contestations of policy pitted the field officer against the forestry expert, with the former doubting both the practicality of the exercise and its desirability in political and environmental terms. Arguments about fire protection revealed the territorial aspirations of the forest department, though they were conducted in the language of scientific certitude. The Deputy Commissioner of Darjeeling suggested the boundaries of government forests be revised to include a smaller area. This in turn would interfere less with the spread of cultivation which would obviate the need for fire protection as more people took to settled farming preference to mobile pasturing. To this officer, as with most district officers in hilly and forested areas, material progress

of the district was linked to the increasing sedentarisation of peasantries in their jurisdiction.[91] The Conservator, Leeds, held to his conviction that widespread fire conservancy was immediately necessary for sal regeneration in Bengal, drawing support from the opinion of the Superintendent of the Botanical Gardens. But the Superintendent, George King, had only pointed out that graziers fired the forests annually for pasture and the conflict was about different objectives of forest management, which in the spirit of the scientist, he found irreconciliable.[92]

Ramachandra Guha and Madhav Gadgil describe several instances of struggle over forest use between peasantries and the colonial Indian state, and in many fire played a role.[93] But one of the best examples of links between forest fire and protest occurred in the case of Punjab, and led to proposals for what could be called the colonial version of joint management. Bhattacharya points out, 'it was in the heart of the forest, where all use rights were expropriated that fires often originated. And frequently they broke out at three or four places simultaneously in the dead of the night.' Local forest officials feeling beleaguered, sometimes brought forth proposals that would return some rights.[94] Such are the instances of pressures from below that create a gap between plan and practice, or even lead to policy amendment, without necessarily being reflected in legislative reform. Crimes of anonymity as E.P. Thompson once called them, however, were not the only way fire was used in negotiating fire conservancy and protection policies.[95] In the eastern Duars, zamindars had always levied a revenue on sal timber and villagers who practised shifting cultivation would not damage certain sal groves near settlements and river banks. In these forests the grass would be beaten down with the rains and burned soon after, causing no damage to regenerating sal poles. Cattle grazing in these woods and pigs rooting alongside (in the case of tribal hamlets) would leave sal seedlings alone. In other fields the grass was grown to three or four feet, called *batha bun*, and this would be harvested as thatch material. Jhumming (swidden cultivation) was practised in more interior forests, where young second growth sal was slashed and burnt for growing cotton. In the 1870s, with the decline in demand for Indian raw cotton and increase in the timber value of sal forests, this complex fire regime was simplified into an unalloyed evil for the forest. Notices on fire protection of sal forests were circulated, but by the admission of the Conservator of the region himself, they were a dead letter, grass was too extensive and the population too scanty to make supervision of such a policy feasible.[96] In this situation the conservator developed a system that combined intense local ecological knowledge and a series of concessions to the hardy Mechi people of the area (woodcutters by profession) to implement a selective fire protection programme.

In forest reserves, grazing was generally prohibited, but concessions to gather edible roots and fruits were usually granted. These collections took place

in the very season that the forest was most vulnerable to fire – the dry, hot summer months. According to Wild, the Bengal Conservator, most fires were caused by these collectors and their carelessness with home-made cigarettes.[97] As the Deputy Conservator pointed out, 'in Singhbhum … the villages are small. The inhabitants are members of a community, perambulate the forests, reserved as well as protected, in small parties … in their search for fruits, honey, roots, sometime game and many parts to collect sabai grass.'[98] A communal responsibility for fire prevention was envisaged in these situations because such gathering activities were permitted only informally, as a local relaxation of a strict wider policy, thereby creating an obligation on the community as a whole. Another proposal was to give specific *mankis* and *mundas* responsibility to supervise fire protection in assigned forest blocks. This would draw on the manki and munda *pattas* where as local police officers they were charged among other things with reporting instances of incendiarism.[99] In 1903-04, fire damage to forests in Singhbhum reached an all time high of 57,330 acres as opposition to fire protection grew and gained a sharp edge. The increase in forest firing was a direct response to the Working Plan, which had made villagers habituated to gathering fire wood from any part of the forest restrict their collection activities to four specified coupes. This was exacerbated by a change in policy from 1900 when instead of selective early burning, complete fire prevention was introduced.[100] Early burning was often confined to those mixed forests (as opposed to sal forests) where grazing was considered the more important revenue source than trees.[101] The failure to reduce the incidence of forest fires caused by gathering activities of tribal communities, however, remained a lasting concern, eluding solution.[102]

Fire control focused on the protection of 'valuable trees' for their timber during the hot months, which was the very season that villagers around the forest used fire to derive from the forest grass, fruit, flowers, small game and other non-timber products that supplemented their diet and income in the agricultural lean season. But in parts of North Bengal there were other problems that occurred during and outside the fire season. Seedlings of planted tun (*Cedrela toona*) and walnut were cut and used to stiffen bundles of grass.[103] Streams were diverted in the cold season by small dams to catch fish, leading the working plan for Tista Division to observe that changes in beds of streams affecting valuable lands have been traced 'directly to this dangerous practice'.[104] At least in this division, elephants were more a menace to the valued forests than local human populations. So fire posed varying degrees of hazard to forests in different parts of Bengal, but in all locations fire control attacked local livelihood directly. It was particularly resented in the protected forests which were considered to be outside reserves and hence not so readily subject to restrictions. These occurred more in South Bengal where non-timber uses of forests were more diverse. Moreover,

fire extinguishing work, in which proximate villagers were hired as coolies were a source of wages in the lean season.[105] In Bengal as a whole, while area covered by fire protection steadily increased, the annual figures of areas burned show no steady decline. They did exhibit distinct regional variations. Thus in North Bengal by 1900 fire protection was effective and quite complete. In southwest Bengal much more of the protected area continued to burn, and the extent to which fire protection would fail was quite unpredictable from year to year. Table 5.2 below shows these figures for the turn of the century, the period when fire protection was most vigorous and largely untouched by controversy regarding its merits for sal regeneration.

Division	1897-98	1898-99	1899-1900	1900-01	1901-02
Darjeeling	-	1	-	16	15
Tista	1	-	-	78	1
Kurseong	56	-	4	382	31
Jalpaiguri	938	24220	23171	24566	68
Buxa	19873	10352	11503	17793	4262
Santhal Parganas	845	4620	2381	247	173
Palamau	34499	13890	11898	3400	11047
Singhbhum	283956	31623	147718	4298	44785
Angul	22120	1762	18270	397	4790
Puri	12738	11558	8539	3207	6062
Sundarbans	-	-	-	-	-
Chittagong	1092	20	1	266	13

TABLE 5.2. Forest Fires in Bengal (area burnt in acres)

Source: OIOC P/6561 BRP (For) April-July 1903, Branch Forests, A progs 21-24, June 1903, File 9R/1, no. 595T-R dated Darjeeling 20 May 1903, A. Earle Offg. Secy GOB Rev to CF Bengal, p. 115. The Sundarbans being mangrove swamps, fire was not an issue.

In Singhbhum it was observed that grazing and fodder collection can reduce the likelihood of fire, while early burning in a three year old coppice forest did no harm to wood production in sal. As the author of the first working plan for Singhbhum had noted, these forests had been burnt regularly till 1884, and except for jhumming areas, nothing had been cut in these reserves till 1900. But fire protection had been notably unsuccessful in increasing the distribution of sal in these forests.[106]

Despite its climatic range, and different provenances, sal in all ecological zones is critically dependant on fire for regeneration. Fire plays a role in both initiating and limiting sal. This means the managed use of fire in the days before scientific forestry and fire protection, was important not only to the production of the subsistence and other annual crops for local communities of the Bengal highlands, but also ensured the perpetuation of the mixed sal forests the British found and chose to exploit. Scientific forestry was a matter of changing the fire regime in the agro-silvical environment natural to sal, with a view to produce pure sal stands in multiple use fields.[107] This produced unintended consequences and a process of structuring scientific silviculture with local knowledge about the use of fire that mitigated some of the more radical transformation of the landscape immanent in prolonged fire protection. A brief consideration of the role of fire in sal regeneration therefore will be useful.

On the eve of his retirement from the position of Inspector General of Forests in 1900, Ribbentrop expansively remarked, 'in the treatment ... especially of *shorea robusta* ... we are now almost universally successful'.[108] His confidence was premature. His departure was swiftly followed by discoveries in North Bengal where certain unintended and undesired consequences of fire protection were noticed. In the damp forests of Buxa, Jalpaiguri and Kurseong young sal foundered against competition from certain evergreen trees and shrubs, regarded as 'comparatively worthless' by the forest department. These had been kept down by fires in the past but under a vigilant system of fire protection were flourishing at the expense of sal. As the evidence of sal suppression by evergreen competition in fire excluded environments mounted, the Bengal government mused whether extension of sal, or even the maintenance of existing sal distribution in the forests of North Bengal would be possible in a regime of unassisted regeneration.[109] In south west Bengal the problems with fire protection were different. Sal regeneration in the reserved and protected forests in Chota Nagpur was generally satisfactory.[110] Forest fires were a more acute problem because of exemptions granted in certain areas like the Rajmahal hills of the Santhal Parganas district where shifting cultivation by Paharias was still permitted. The hillmen never complied with rules that required them to report in advance areas to be burned for jhumming and these violations were treated as acts of incendiarism.[111] Though a practice of appointing fire watchers had developed, the Conservator ruefully noted in 1907 that there were so few convictions on reports of malicious forest burning that fear of punishment was certainly an unlikely deterrent.[112] An amendment proposed to Act VII of 1878 in 1916 envisaged 'making it incumbent on village officers to extinguish and prevent fires on their own initiative'. In the past they were only required to assist forest officials if asked. This casting of responsibility was expected to bring forth the cooperation of privilege holders and their servants through whom the village officers would function.[113]

As we can see here, fire protection and its aftermath brought different issues to the fore in North and South Bengal. Discrepant results from fire protection produced regionally varied responses as scientific forestry was inflected by particularities of ecology and politics. In southwest Bengal, the region of dry sal, fire protection was confounded in various ways, so problems arose from its incompleteness. In North Bengal, the domain of moist sal, fire protection was too successful, its completeness unleashed ecological transformations that were unsought.[114] What happened in the North is of great salience because, along with a parallel critique of fire protection in the teak forests of Burma, the experience of sal regeneration there permanently undermined the consolidation of scientific forestry and sent its planners scurrying back to the drawing board, arguing furiously among themselves. What emerged from those frantic decades was a critique from within, a privileging of local knowledge, a fractured wisdom tersely expressed by a participant in the All-India Sal Study Tour of 1953 thus, 'for the success of sal natural regeneration close individual attention and intimate knowledge of local conditions are essential'.[115] Bengal foresters learnt the political pertinence of local knowledge most often in southwest Bengal and the dry sal zone, but the moist sal and savannah complex of North Bengal was the landscape where ecological aspects of local knowledge became crucial to the construction of the discourse of sal silviculture and so we shall turn to that next.

In the earliest working plans for the Duars, the prescribed treatment was selection with improvement felling, cleaning after main felling for five years, fire protection and creeper cutting. By 1903 lack of success under this treatment had led to one round of revisions in working plan in the Duars. Selection felling and cleaning came under increasing criticism in the next ten years.[116] Fire was resolutely kept out of the treated areas, even as recognition grew that such treatment was introduced in a landscape that was seen to be marred by constant firing where the undergrowth prior to fire protection was principally savannah grasses.[117] Revising the first Jalpaiguri working plan, Trafford documented the undesired transformations of the forest induced by forest protection. The first coppice felling had taken place in 1892-93 and 'by the fourth year dense mass of creepers ... smothered all coppice shoots … by sixth year coppice shoots of malota and other species had overtopped sal shoots … which by the twelfth year had disappeared... the forest having become a dense thicket of creepers and poles'.[118] Trafford prepared a numerical estimate of this phenomenon over 244 acres that can be seen in table 5.3. Despite such mounting evidence, the Conservator of Forests Bengal, even in 1915, argued in favour of using *mallata* as a cleaning agent rather than fire, stating that difficulties with labour, pig damage, fire and soil working made artificial regeneration hard.[119] Sal regeneration and advance growth was found in this fire ordered landscape, in blocks and patches, and at that point simple protection had released this young growth. But protection also changed the character of the undergrowth into one dominated by

Year	< 3 inches	3-6 inches	6-9 inches	9-12 inches
1894-95	not recorded	2212	2636	2832
1904-05	very scarce	1200	1663	2523
decrease		1012	973	309

TABLE 5.3. Sal saplings in different diameter classes

Source: Adapted from information in Trafford, *Jalpaiguri WP*, p. 5

climbers and evergreen shrubs. This in turn had such disastrous consequences for further sal regeneration that sal began to disappear from these forests, so eminently suited to its growth. In contrast, the adjoining zamindari forests in Goalpara district were annually burned and grazed. Sal regeneration was profuse, and in fact more plentiful in grazed areas.[120]

By 1910, the regeneration of sal in North Bengal had become a serious problem and small scale experiments in clearing and planting areas had begun.[121] The other option considered, and found unsuitable for producing even-aged crops economically, was systematic burning and attempting to secure the savannah type undergrowth of twenty years earlier. Finally both fire and grazing came to be integrated as management methods at different points in the sal rotation of eighty years proposed under taungya.[122] The taungya method of direct sowing and cultivation of sal offered all the potential advantages of contiguous areas stocked with even-aged sal in regular series of age gradations.[123] A few years later the Inspector General of Forests visited some of the sown areas and noted that the sal sown with a *bhadoi* crop was doing better than that sown in grassy lands fallowed for some years. The problem now was that the bhadoi sowing and concurrent weeding of sal in the second and third years was desirable to assure a good crop, but such intensive cultivation demanded a labour supply that was not available.[124] Uncertainty and difficulty faced in securing labour, both in sufficient quantity and in season, hampered planning. So the introduction of taungya methods of sal regeneration, though found silviculturally the most appropriate, was made provisional through a five year working scheme. Once again, the hesitation to formalise the plan stemmed from the perception of an insufficiency in knowledge – about bhadoi crops, other tree species that could be introduced in the taungyas, and labour needs.[125] While concentrated regeneration blocks was the prescribed ideal, labour shortages dictated a patchy clearing of small areas and taungya sowings in them.[126] At all levels, the foresters were acutely aware that they were in a period of confusion and experimentation –

scientific forestry was coming unravelled and needed to be reconstituted. The Conservator of Forests, Bengal went so far as to suggest that nothing more than annual working schemes could be proposed till such time that the experiments yielded sufficient information to safely build another edifice of plans.[127] As artificial regeneration stabilised in North Bengal, the question of forest labour was addressed through the creation of forest villages. But difficulties with labour more often meant that selection fellings continued as the dominant system of management. In the waterless (bhabhar) areas of North Bengal, the sal regeneration had responded favourably to annual firing which eliminated evergreen undergrowth without damage to *sau* grass or sal. The necessity of annual firing was discovered, ironically enough, on the northern limits of the managed forests where fire protection had not been fully extended.[128]

The introduction of fire protection as a forest management and regeneration strategy was contested almost from the very beginning. Following Brandis, who had recommended it for teak based on his Burma experiences, most foresters in the Central Provinces, United Provinces, Bengal, Madras, Western India and Punjab made it a centrepiece of forest conservancy in the years of conservative lumbering.[129] But even by the early 1870s, district officers were voicing their discontent and objection to this policy. We have already encountered some of the cases from Bengal. In some ways these tensions arising from fire protection are easy to anticipate when we examine the most common causes of forest fires. These turn out to be, according to a report prepared on the subject in 1875, taungya or other forms of shifting cultivation (*jhum*, *kurao*, *bewar*), hunting small game, refuse burning, cleaning paths and tracks to avoid snakes, burning back forest fringes of villages to keep off tigers and bears, cleaning the air and killing of insect pests, and securing fresh pasture and thatch grass crops.[130] Brandis himself had not failed to note the beneficial fertilizing effects of wood ash from forest fires on teak taungyas. In a later report on the forests of North Bengal, Brandis expressed doubt whether fire protection was going to yield sal regeneration.[131] Despite the early misgivings, fire protection proceeded apace, gathering momentum to such a degree that in the decade, 1896-97 to 1906-07, the area covered in India increased from 1856 square miles to 8153 square miles.[132] But even the colonial forest historians were later compelled to admit that indiscriminate fire protection served more a political purpose of asserting unequivocal forest department control over newly reserved areas, than any scientific plan for regeneration of these areas. But since it was done in the name of both conserving and enhancing forest wealth, fire protection, initially attacked by local officers of civil administration, soon came under the critical scrutiny of those charged with the management of forests, namely, field foresters.[133]

Slade argued that low ground fires removed slash, minimised fungoid and insect pests and had in fact produced the teak forests that were later reserved. A

few years later, R.S. Troup published the results of experiments in Tharrawady where he had found that unprotected plots of teak had more sound stems, ten times more seedlings, and that stems in these plots were in no danger of suppression as were half those in protected plots. He was led to remark, 'we are most certainly exterminating our teak by fire protection.[134] Other foresters in eastern India corroborated. In 1907, the CCF of Burma, Beadon Bryant offered the dire prognostication that the combination of selection felling and fire protection was killing out teak in most Burma forests.[135] The first two decades of the twentieth century saw the pages of *Indian Forester* filled with debate on fire, grazing and forest regeneration. This did not presage the overturning of former attitudes to these 'biotic factors'. But it certainly prevented any consensus on these issues and forced a re-examination of categories through which both scientific forestry and its Other were defined.

By 1925 fire had entered the working and management of forests as an element of taungya in North Bengal, parts of United Provinces and of course Burma.[136] In Assam fire protection had been given up by 1915, while the introduction of taungya provided a mediation of the needs of forest regeneration and the growing demands for land by Kukis, Lushais and Cacharis.[137] The intensification of regeneration work that was involved in taungya was resented not only by jhumiyas but also the subordinate staff accustomed to less strenuous revenue station work.[138] In other parts of eastern India as was the case elsewhere, it appeared in the form of 'early burning', where the forest floor was burned just before the advent of the dry season to prevent unmanageable conflagrations at a later time.[139] The growing scepticism about fire exclusion as a viable regeneration strategy for teak and sal forests in eastern India was supported by similar contestations of fire protection policy in United Provinces and Central Provinces.[140] Fire protection had become silviculturally unsound, financially unviable and impractical in labour scarce forest areas. But more importantly the discovery of a positive role for fire in forest regeneration meant that one foundational feature of scientific forestry, its radical separation from anything unscientific by the definition of fire as bad for forests, came to be questioned, came under fire. In the years to follow, the management of fire in scientific forestry, especially in sal and teak forests remained a troubled issue. The destabilisation of scientific forestry that ambiguity about fire entailed ultimately led the forest department away from natural regeneration of endemic species to a regime of planted exotics in the schemes of post-colonial forest development.[141]

In its optimal habitat (Duars, Assam), the continued fire protection of *Shorea robusta* for a period of about 40 years (1890-1930), altered the character of the forest, introducing a previously non-existent evergreen undergrowth, increasing the soil moisture and decreasing the soil aeration: in consequence of this even though the previously established crop continued to flourish, the tree seeded freely and seeds germinated, new regeneration could not establish itself.[142] At

this stage regeneration of a forest too damp to burn posed a problem and the only way out seemed clearfelling, burning the dry refuse, soil working and artificial regeneration. The case of the Duars is instructive about how sal profits from adverse conditions to establish gregariously, and altering conditions, apparently for the better can cause it to recede.[143] The sal forests of Assam were originally thatch lands, mainly *Imperata cylindrica* with sal seedlings nestling in the grass. Fire protection released the sal seedlings and as the canopy of the sal forest closed, the grasses were suppressed.[144] The sal forests of the North Bengal duars and terai had a similar origin. This suggests that successful regeneration of sal depended on a regulated use of fire and the knowledge of the ecology of the sal forest before the introduction of fire protection, which remained a problem. Smythies compared the sal forests of the United Provinces terai and those of Nepal and pointed out that in Nepal without fire protection sal regeneration was good. In the United Provinces after fire protection sal regeneration failed due to seeds not reaching mineral soil through the thick mat of evergreen undergrowth, and where the seed did penetrate the forest floor, excess moisture and poor light retarded germination.[145]

The quest then was for reversal of conditions to re-obtain the grassy conditions favouring sal regeneration. In North Bengal, the path of taungya was taken, but in Assam some success in reversal was achieved by the Conservator Milroy. In Assam, extensive burning was done during 1916-1926 to release the sal seedlings and hasten their establishment, as also to facilitate germination. As

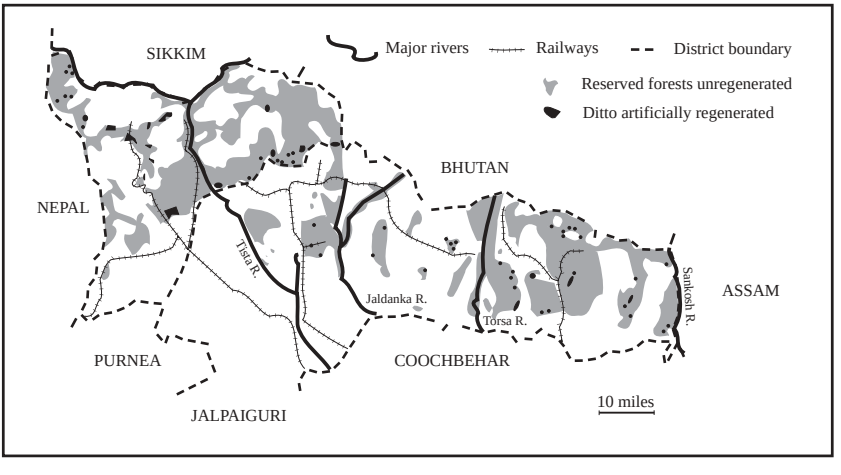


FIGURE 2. North Bengal Forests and Areas under Artificial Regeneration

Source: *Bengal Forest Administration Report, 1928-29.* Calcutta: Bengal Secretariat Press, 1930 (redrawn).

Milroy noted the only alternate method was hoe cultivation, something the introduction of taungya acknowledges. A subsidiary local effect of burning was that it encouraged stool shoots to be thrown out by even quite large stumps stimulating them in a way that fire protection had not done. This had to be combined with canopy opening to simulate 'Boko' conditions.[146] Reversal regeneration as this came to be known, combined regulated canopy opening and controlled fire to induce in the forest floor a carpet of *Microstegium ciliatum*, then *Imperata cylindrica*.[147] The latter grass acts as a seed nurse for the sal seedlings which as they establish suppress the grass.[148]

The case of fire provides an excellent example of what Gyan Prakash calls the revision of the categories of colonial discourse in the process of their historical articulation.[149] Indian field foresters were discovering that agro-pastoral peasantries used fire in preparing land for periodic low intensity agriculture, to drive game in the hunt and to release fresh tender herbage for pasture dependent cattle. As Michael Dove says, savannah is often 'a fine balance between the forces of society and the forces of nature'.[150] Scientific forestry developed a whole pejorative vocabulary for this condition. While the jungle aspect of savannah had been the conservatory in disorder, an obstacle to political goals and human progress in the early nineteenth century, the more closely observed bush savannah revealed overgrown grass lands with sal seedlings that to the scientific forester appeared trapped in a sub-climax state. Fire protection released these seedlings and as they grew to climax they suppressed grass. This notion of climax, based on the most hygrophilous composition of the forest was based on the exclusion of anthropogenic influences, and was expected to yield the most valuable woods, once the thorny issue of evicting tribals and other peasant users from the forest was resolved. On both these counts scientific forestry faced a serious challenge from within and without.[151] Having considered some of the problems created by indiscriminate fire protection and the emergence of a critique from both within the forestry bureaucracy and outside, it is possible to surmise that controlling fires proved to be one long lesson in forest ecology for scientific forestry. The representation of fire was closely related to the representations of grass. The perception of grass had to do with the agro-forestry system in vogue, and the desirability of annual or perennial grasses in that system as a fallow period crop. Conflicts over this perception led to the incendiary use of fire, the critique of scientific forestry from without.[152]

Scientific forestry began, to restate our argument briefly, with forest departments locating and demarcating forest reserves, then regulating local demands for forest produce. Intervention in the ecological regimes of forests was primarily directed at managing natural regeneration to maximise certain timber values, though a complementary plantation programme was usually carried on. It is useful to distinguish the Bengal and Central Provinces cases from the Uttarakhand

region, because in zamindari areas reservation succeeded a period of private forest management where forests had been classed with other wastes in landed estates. In these situations reservation was superimposed on a more complex hierarchy of rights and localised arrangements than in the temperate evergreen or deciduous forests of the Himalaya. Early management was heavy handed: foresters saw only the timber they needed, villagers saw a variety of use values being destroyed. But a more fragmented discourse of scientific forestry emerged from the crude regulatory strategies initially employed. Niladri Bhattacharya sums up well when he says, 'the demands of different social classes and their attempts to protect and assert their rights had to be reconciled with what the colonial state perceived as its interest … conflict of opinion among different officials reflected the different ways in which reconciliation was sought'.[153]

In the mixed deciduous plains forests, forest officers concentrated on one or two valuable species like sal, with the result that no silvilcultural knowledge was accumulated on the large number of other species that might have value in the future.[154] This emphasis on the production of pure sal and teak forests in the main and pure stands of other valuable species (the trees varied regionally), was clearly the upshot of managerial compulsions, the necessary regimen of departmental functioning. Persisting with such a simplified species composition approach had adverse consequences for silvicultural knowledge. Few species and their concentrated regeneration, though imported as a system from Europe, outlasted its inspiration in India. Bavarian forestry had begun to emphasise mixed forests for the production of timber even in the 1860s, for it supported denser growth, finer timber qualities and better resistance to pest and disease. By 1876 in France 70 percent of managed forests were of mixed composition.[155]

Unmindful of these continental developments, and concentrating on one species, foresters in the United Provinces, Bengal and Assam launched regeneration experiments on sal during the first three decades of the twentieth century, documenting much of what we know about the silvics of sal. In the course of this work it was discovered that sal seedling growth occurs in spurts, helped by rains in October and spring. Dieback of the seedling was recognised as an adaptation to edaphic conditions and natural hazards, a physiological trait that served the species well under conditions of biotic interference that mainly meant fire or soil compaction.[156] Dieback also indicated sal might be a recent entrant in sites where this phenomenon was noted, and minimising dieback was then expected to secure colonisation of forest blanks and savannah areas on the forest fringe, thereby extending the estate of sal.[157] It seemed to occur when the taproot developed with sufficient vigor to withstand adverse influences, which could be drought or poor soil aeration. The seedlings thus recovering were of large leaf, whippy, and small woody morphology. The period of annual dieback could be a long one depending on the rate of amelioration of adverse conditions. Seedling mortality can be considerable, but the dieback phenomenon ensured that this only happened after a protracted struggle, during which there was steady

development of the taproot. Smythies reported that poor light could also cause dieback. Chaturvedi found a light fire in March helped shoot growth which progressed rapidly through the monsoons to be followed by a dormant cold season.[158]

The researches of R.S. Hole during 1909-1921 are specially significant in the study of sal natural regeneration. He identified that excessive soil moisture, and poor soil aeration can cause prolonged die back and retard seedling growth. A layer of dead leaves on the forest floor could prove a mechanical impediment to the movement of air and water through upper parts of the soil profile and reduce light for germination. Hole suggested soil working, burning and removal of overhead canopy, while keeping side shade.[159] Smythies disagreed with him on canopy density effects on sal regeneration. Smythies and Champion also did several field experiments, and were a greater influence on the United Provinces Conservator of forests, who ultimately rejected Hole's proposals that sal be raised in cleared patches.[160] Hole insisted that heavy shade, raw humus, acidity and weed competition were inimical to sal regeneration. Smythies and Champion's experiments in 1920s tried different combinations of overwood, leading to the conclusion that clearfelling, sparse shelterwood, and strip felling methods gave whippy sal regeneration which responded well to light, but sambhar deer browsing and weed invasion overtook these young stands. Heavy felling and fierce burning of refuse produced *haldu* (*Adina cordifolia*), which suffered the same fate as the whippy sal, in the face of weeds and deer. Dense shelterwood (50-60 standards per acre) worked better, leading Smythies to deduce that sal seedlings needed ample light, protection from deer and protection from weed competition.[161] The Kamrup model was similar except for the heavy felling part. In his 1930 tour note of Assam the Inspector General of Forests wrote that 'success has also been obtained by jhumming in Borjuli', recognising not only the importance of fire to sal regeneration but the possibility of making fire regimes of forestry and agriculture compatible. Hence canopy opening and fire both become important to sal regeneration, particularly in the moist zone.[162]

Till 1910 all the sal forests in Bengal were worked under the selection method with some improvement felling, a system necessitated by the supply of large sal trees being scant and dispersed through the forests.[163] In the decade following the first world war, radical changes were introduced in the silvilculture of sal. By the late twenties, Shebbeare, the Conservator of Forests in Bengal who fifteen years earlier had pioneered taungya experiments for sal in North Bengal, could report that taungya had become the single most important means to regenerate sal forests. Taungya was a method of raising pure plantations that was labour intensive and required land preparation by clear-felling and firing of scrub. But the advantage was that the outcome was easily managed for timber. Taungya working plans were simple. They prescribed clear-felling and restocking 1/r of the total area every year, where r was the length of rotation, usually 80 years.[164] One consequence of taungya and the switch to concentrated regeneration of any

other sort was that trees like mahua (*Bassia latifolia*), valued mainly for their non-timber forest product yields to villagers, were also removed under silvicultural prescriptions. Under earlier selection systems they were left alone in recognition of their utility to local people.

FIGURE 3. Original high forest in the hills of Kurseong Forest Division

Source of figures 3-8: *Bengal Forest Adminisration Report, 1928-29*. Calcutta: Bengal Forest Secretariat Press, 1930. Reproduced by permission of the Syndics of Cambridge University Library.

During 1926-1939 most sal forests were brought under the Uniform System, but within the next ten years this was being given up as it was found that natural regeneration of sal could not be obtained through canopy manipulation.[165] As the sal study tour had noted, the conversion to Uniform System was predicated on the belief that regeneneration de novo could be established in sal forests through the management of edaphic and light factors. But the highly mixed results had revealed that success was limited to regions with existing adequate advance growth, which was 'due to the past history of the forest, not the purposeful action of the forest officer'.[166] Ironically, this was a condition that could only obtain under conditions not subject to the criteria of scientific management, namely,

FIGURE 4. A clear-felling coupe in hill forest, Kurseong Division, showing firewood cutting and stacking, sawyers at work and the newly constructed houses of forest villagers who will grow field crops over the area and plant it up with tree seedlings.

FIGURE 5. A taungya plantation area in the hills, staked 6 feet by 6 feet for planting and sown with villagers' crop of Indian corn.

FIGURE 6. A plantation area at Sukna, Kurwong Division, showing 3-week old sal (*Shorea robusta*) seedlings in lines interplanted with jute (in background) and *Tephrosia candida* (in foreground) as nurses.

FIGURE 7. One and a half year old sal (*Shorea robusta*) with bogamedeloa (*Tephrosia candida*) as a nurse at Suka, Kurseong Division.

FIGURE 8. 8-year old sal (*Shorea robusta*) plantation at Sukna, Kurseong Division.

financial prudence and standardised silviculture. Field foresters in the late 1920s were finding that sal seedlings established in situations of varying light, possible only under an uneven aged canopy. Felling to simulate these conditions would be both uneconomical and violate the ideal of concentrated regeneration blocks.[167] Conversion to the Uniform System had failed on several counts. First preparatory felling did not induce regeneration; second, final removal of overwood damaged established crops; third, the debris of concentrated felling posed a pest and fire hazard; fourth, in damp areas weed infestation became rampant.[168]

While Osmaston recommended giving up concentrated regeneration for a revised group selection system, he also stressed the importance of an understorey of *Mallotus phillipinensis*, *Woodfordia floribunda*, *Wendlandia tinctora* and *Indigofera pulchella* to minimise canopy drip and suppress grass.[169] Another forester noted the damage to sal from deer, something that had increased with the depletion of their predator carnivora, hunted as vermin, and the reduction of inedible shrubs in the regeneration areas, making sal and important associates like haldu (*Adina cordifolia*) more vulnerable as deer quickly learned to prefer areas in the forest exclusively stocked with plants palatable to them.[170] Thus the debate on sal regeneration, by the 1930s, systematically brought into question every foundational aspect of scientific forestry as posited over the previous fifty years. The blanket exclusion of fire and grazing in regeneration areas; the distinction between valuable and valueless trees and efforts to eliminate the latter to maximise the former; the aesthetic and managerial ideal of the model forest consisting of even aged orderly stands of desired trees; the possibility of laying down plans that would prescribe treatments and procedures for eighty to a hundred and fifty years on the basis of conjured models; all this and more had become suspect. From different sites a consensus on mixed overwoods and intermediate storey vegetation was developing, but its composition and treatment defied generalisation.[171] That sal needed a mixed canopy of trees and shrubs of all heights became increasingly clear. The crop itself should preferably be irregular, interspersed with associates and under an undulating broken canopy.[172] Seedlings germinated better under a mixed cover than one of pure sal as this was lighter, leaves from such a canopy degenerated more easily after falling, and a mixed canopy suppressed weeds without suppressing sal.[173] Thus did the Uniform System come under critical scrutiny.

A range of practices incorporated fire into sal regeneration. Many of them have been discussed earlier in the chapter. Here we need merely recapitulate the variety of silvicultural benefits that came to be identified with the use of fire, especially in moist sal forests. We should also note that these reports spanned a multiplicity of political-ecological settings in eastern India. Fire was found not only to suppress weed undergrowth but continued largescale burning destroyed *Clerodendron infortunatum* and other 'noxious weeds' in their flowering season and thus prevented recurrence.[174] The introduction of early burning of the forest floor for soil aeration and exposure of mineral soil to falling seed has already been discussed.[175] Regular burning not only possessed the advantage of avoiding heavy occasional fires, but flocculated and sterilised damp ground.[176] But most importantly, reconsideration of the relationship between fire and sal forest landscapes recalls our discussion of nature and representation, the conundrum of 'first nature' and 'second nature'. Struggling with the natural regeneration of sal, in Bengal and other parts of eastern and northern India, foresters redefined primary and secondary landscapes. In their recognition that fire protection established *an entirely artificial condition of affairs*, we can detect the interplay

of knowledge, power and nature. On the eve of the second world war, the national silvicultural conference was still calling for research on sal regeneration and the problems of pure teak plantations, pointing to the enduring problems in the silviculture of the two most valued species of Indian forests.[177] The same issues were revived as Indian foresters convened for sal and teak regeneration planning after India's first post-independence National Forest Policy was announced in 1952.[178]

Scientific forestry thus retained a botanical focus on silvics of individual tree species which combined with a territorial approach to forest control. The forest-savannah transition zone in which all advance growth of sal was found in Bengal at the inception of forest reservation and protection was pictured as a regression from the climatic climax.[179] In southwest Bengal, what was considered a biotic and edaphic subclimax vegetation had been carefully created by years of complex agroforestry. Many valuable fruit trees of the region like mahua and *kendu* regenerated only in this zone. Shrubby vegetation not only encouraged the proliferation of microfauna, but when burnt on the forest floor, the ash was washed down by monsoon rains to fields at the bottom of slopes and fertilised the otherwise shallow and nutrient poor soils.[180] An associate considered valueless, *Lagerstroemia parviflora*, and *Clerondendron*, which became the noxious weed of later struggles for sal regeneration, were indicator species for favourable sal sites.[181] Troup had demonstrated that the progression from savannah to sal to evergreen that he described for moist forests of North Bengal was the first indication of a wider phenomenon. Mobbs and Bourne wrote in detail about the succession of landscapes that produced sal forests, pointing out how fire and grazing produced forests through complex transformations.[182] When we imagine many years of such transformations we can picture forest islands in fields and savannah, but not 'first nature'. An interest in specific trees and not the forest combined with a misconceived notion of 'first nature' in colonial science to produce a narrative of degradation.[183] One forester summed up aptly when he said, 'we talk glibly about following nature and forget that the nature we are visualising may be a European nature inherited from our training and not an Indian nature'.[184]

British introduction of scientific forestry was thus a radical simplification of the forest to maximise a single value, namely, hardwood timber. The study of silvics, of a few species like sal, teak and hardwickia came to dominate Indian silviculture during the colonial period.[185] The focus was on single species, and securing their growth, preferably in even-aged stands. Both ecology and local knowledge were discounted. In Bengal, shelterwood systems became very important for sal regeneration. The Government put a lot of effort and money into weeding and tending to release sal at the cost of other species, something that could have been obviated by paying greater attention to natural processes. What modern silviculture recommends is a focus on stand dynamics and floristic

associations, thus taking advantage of facilitative and competitive mechanisms inherent to the natural process.[186] Yet the urge to such simplification continues to lie at the heart of scientific forestry as it has emerged from the post-enlightenment views of nature and colonial exigencies of rule. In this context natural regeneration, which could favour local knowledge, remains caught up in contrary imperatives. Similarly the role of fire eludes a policy consensus.

Uncertainty about and disregard for the admixture of local ecology and politics that shaped the successes and failures of forest management in Bengal are then an important thread of continuity through the colonial period and beyond. But asking why these persistences in forest management are significant, this paper has focused on the production of regional forest management regimes. Adopting such a carefully situated and process-oriented mode of unravelling scientific forestry, and its related state forms, leads to some revisions in the debates surrounding forest management and colonialism in India. First, while major ecological transformations were introduced by scientific forestry, they were not so much a drastic change in forest tree species as a change in the proportion of woody biomass that the forests produced. This is an important qualification because such amendment shows the character of struggles around forest use and management to be significantly different. While the pursuit of timber by the state was a unifying theme across regions, differences in the manner and style of that pursuit produced regional variations.

Second, the corpus of knowledge that we gloss as scientific forestry was evidently more inchoate, contested and shot through with contradictions than has been allowed in earlier studies. The significance of this conclusion is that we are compelled to focus on the local and historical conditions of knowledge production and its deployment, thereby recovering the ways by which this production remains an ongoing process. Scientific forestry has frequently been treated as received doctrine, either emerging from the intellectual history of western science, or from the imperial, exploitative project of colonialism. Such consolidation of the identity of scientific forestry over time and space inadequately acknowledges, let alone explains, the misadventures and experiments through which it was crafted. We are then likely to miss as well the part played by particular colonial locations in these several historical modifications and reconstructions of scientific knowledge.

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ABBREVIATIONS USED

Agri = Agriculture; BFAR = Bengal Forest Administration Report; BORP = Bihar and Orissa Revenue Proceedings; BRC = Bengal Revenue Consultations; BRP = Bengal Revenue Proceedings; Cal = Calcutta; CF = Conservator of Forests; Coll = Collection; Commr = Commissioner; *CSSH = Comparative Studies in Society and History*; DC = Deputy Commissioner; DCF = Deputy Conservator of Forests; *EFJ = Empire Forestry Journal*; For = Forests; GOB = Government of Bengal; GOBO = Government of Bihar and Orissa; GOI = Government of India; *IESHR = Indian Economic and Social History Review*; *IF = Indian Forester*; *IFB = Indian Forest Bulletin*; *IFR = Indian Forest Records*; IGF = Inspector General of Forests; LP = Lower Provinces; *MAS = Modern Asian Studies*; NAI = National Archives of India, New Delhi; Offg = Officiating; OIOC = Oriental and India Office Collections, London; Progs = Proceedings; Res = Resolution; Rev = Revenue; Secy = Secretary; US = Under Secretary; Vol = Volume; WBSA = West Bengal State Archives, Calcutta; WBSRR = West Bengal Secretariat Record Room, Calcutta; WP = Working Plan

Jan = January; Feb = February; Mar = March; Apr = April; Aug = August; Sep = September; Oct = October; Nov = November; Dec = December

NOTES

[1] Stephen Pyne, 'Nataraja: India's Cycle.of.Fire', *Environmental History Review*, 18(3): 21-36, 1994, p.11.

[2] B.H. Baden-Powell, 'Forest Conservancy in its Popular Aspect', *IF*, 2(1): 1-17, 1876-77, p. 2.

[3] David Anderson and Richard Grove, 'Introduction: The Scramble For Eden: Past, Present and Future in African Conservation', in Anderson and Grove (eds) *Conservation in Africa: People, Policies and Practice*, Cambridge: Cambridge University Press, p. 4-6, make this point in the African context.

[4] Sir Dietrich Brandis, *Suggestions Regarding the Management of Forests in Jalpaiguri and Darjeeling Districts*, Calcutta: Home, Revenue and Agriculture Department Press, 1881. Recently, this point and its implications for policy in parts of Africa, have been documented by James Fairhead and Melissa Leach, 'Reading Forest History Backwards:

The Interaction of Policy and Local Landuse in Guinea's Forest Savannah Mosaic', *Environment and History*, 1(1): 55-91, 1995.

[5] F.C. Ford-Robertson, 'The Problem of Sal Regeneration With Special Reference to the "Moist" Forests of the United Provinces', *IF*, 53(9): 500-511; 53(10): 560-576, 1927, p. 511.

[6] Barrington Moore, 'Notes on the Forests of Northem India and Burma', *IF*, 35(4): 213-19; 35(5): 257-62, 1909, pp. 218-19.

[7] Gyan Prakash, 'Science "Gone Native" in Colonial India', *Representations*, 40: 153-177, 1992, p. 164.

[8] Ramachandra Guha, *The Unquiet Woods: Ecological Change and Peasant Resistance in the Himalaya*, Delhi: Oxford University Press, 1989, p. 35-60, pp. 59.

[9] Michael Worboys, 'The Imperial Insitute: The State and Development of the Natural Resources of the Colonial Empire, 1887-1923', in J.M. Mackenzie, (ed.) *Imperialism and the Natural World*, Manchester: Manchester University Press, 1990, pp. 164-186.

[10] Michael Worboys, 'The Discovery of Colonial Malnutrition Between the Wars', in D. Arnold (ed.) *Imperial Medicine and Indigenous Societies*, Manchester: Manchester University Press, 1988, p. 208-225; David Arnold, 'The Discovery of Malnutrition and Diet in Colonial India', *IESHR* 31(1): 1-26, 1994, p.2.

[11] Deepak Kumar, 'Patterns of Colonial Science', *Indian Journal of History of Science*, 15(1): 105-113, 1980; Satpal Sangwan, *Science, Technology and Colonization: an Indian Experience, 1757-1857*, New Delhi, 1992; Deepak Kumar, 'Science, Resources and the Raj: a Case Study of Geological Works in Nineteenth Century India', *Indian Historical Quarterly*, X: 1-2, 66-89, 1984; Susan Sheets-Pyenson, 'Cathedrals of Science: The Development of Colonial Natural History Museums during the late Nineteenth Century', *History of Science*, XXV: 279-300, 1986.

[12] Robert Stafford, 'Geological Surveys, Mineral Discoveries and British Expansion, 1835-1871', *Journal of Imperial and Commonwealth History*, 12: 5-32, 1984; idem., 'Annexing the Landscapes of the Past: British Imperial Geology in the Nineteenth Century', in Mackenzie, *Imperialism and the Natural World*, p. 70.

[13] A small sample of this historiography would include, Robert Stafford, *The Empire of Science: Sir Roderick Murchison, Scientific Exploration and Victorian Imperialism*, Cambridge: Cambridge University Press, 1989; Janet Browne, *The Secular Ark: Studies in the History of Biogeography*, New Haven: Yale University Press, 1983; Adrian Desmond, *Archetypes and Ancestors: Paleontology in Victorian London, 1850-1875*, Chicago: Chicago University Press, 1984.

[14] Stafford, 'Annexing the Landscapes of the Past', p. 82.

[15] J.M. Mackenzie, 'Introduction', in Mackenzie, *Imperialism and the Natural World*, p.5.

[16] Mackenzie, ibid., pp. 3-4.

[17] As Arun Agrawal explains, 'a classification of knowledge into indigenous and western is bound to fail not just because of the heterogeneity between the elements ... it also founders at another possibly more fundamental level. It seeks to separate and fix ... in time and space systems that can never be thus separated or so fixed. Such an attempt at separation requires divorced historical sequences of change for the two forms of knowledge – a condition evidence simply does not bear out.' See his, 'Dismantling the Divide Between Indigenous and Scientific Knowledge', *Development and Change*, 26(3): 413-39, 1995, pp. 421-22.

[18] Satpal Sangwan, 'Reordering the Earth: the Emergence of Geology as a Scientific Discipline in Colonial India', *IESHR*, 31(3): 291-310, 1994, pp. 292-293.

[19] Ibid., p. 309; the critical, if unacknowledged role of local or indigenous knowledge in the formation of imperial science in the context of irrigation technologies in the Indus basin is discussed by David Gilmartin, 'Scientific Empire and Imperial Science: Colonialism and Irrigation Technology in the Indus Basin', *Journal of Asian Studies,* 53(4): 1127-1149, 1994, pp. 1130-32. Such scientific systematisation and classification of colonial knowledge through the transformation of local information has been ably discussed for agriculture and rural life by Shahid Amin, 'Introduction', *William Crooke's Glossary of North Indian Peasant Life,* Delhi: Oxford University Press, 1989.
[20] Richard Grove, 'Conserving Eden: The (European) East India Companies and their Environmental Policies on St. Helena, Mauritius and in Western India, 1660 to 1854', *CSSH,* 35: 318-351, 1993; Mahesh Rangarajan, 'Imperial Agendas and India's Forests: the Early History of Indian Forestry, 1800-1878', *IESHR,* 31(2): 147-167, 1994, p. 148.
[21] Richard Grove, 'The East India Company and the El Nino - The Critical Role Played by Colonial Scientists in Establishing the Mechanisms of Global Climatic Fluctuations and Teleconnections between 1770 and 1930', unpublished mimeo, 1995, pp. 1-7.
[22] Ibid., p. 2, 5.
[23] Mary Louise Pratt, *Imperial Eyes: Studies in Travel Writing and Transculturation,* London: Routledge, 1992, pp. 34-35, 202.
[24] Michael Anderson, 'The Conquest of Smoke: Legislation and Pollution in Colonial Calcutta', in David Arnold and Ramachandra Guha (eds) *Nature, Culture, Imperialism: Essays on the Environmental History of South Asia,* Delhi: Oxford University Press, 1995, p. 296.
[25] Mackenzie, 'Introduction', p. 8; a fine study exposing the complex interweaving of means and motives in imperial rule is Daniel Headrick, *The Tentacles of Progress: Technology Transfer in the Age of Imperialism, 1850-1940,* Oxford, 1988.
[26] The expression 'development regime' is defined by Ludden as: 'an institutional configuration of power within a state system ideologically committed to progress that draws its material sustenance from the conduct of development.' See David Ludden, 'India's Development Regime', in Nicholas Dirks (ed.) *Colonialism and Culture,* Ann Arbor: University of Michigan Press, 1992, p. 252.
[27] David Demeritt, 'The Nature of Metaphors in Cultural Geography and Environmental History', *Progress in Human Geography,* 18(2): 163-185, p. 165.
[28] F. Trafford, *Working Plan (revised) for the Reserved Forests of the Jalpaiguri Division,* Darjeeling: Bengal Secretariat Tour Press, 1905, p. 11.
[29] For standard accounts of this transition see, Robert P. McIntosh, *The Background of Ecology: Concept and Theory,* Cambridge: Cambridge University Press, 1988; E.P. Odum, *Fundamentals of Ecology,* Philadelphia: Saunders, 1971 (3rd. edition); Robert Ricklefs and Dolph Schluter (eds) *Species Diversity in Ecological Communities: Historical and Geographical Perspectives,* Chicago: Chicago University Press, 1993. Aldo Leopold, *Game Management,* Madison: University of Wisconsin Press, 1986 (first published in 1933), pp. 3-22; and Arthur McEvoy, *The Fisherman's Problem: Ecology and Law in the California Fisheries, 1850-1980,* Cambridge: Cambridge University Press, 1986, p. 118, note this movement in connection with game and fisheries management in the US.
[30] Though schematised and erased to some extent in his presentation, the transition can be discerned through a careful reading of R.S. Troup's *Sylviculture of Indian Trees,* Delhi: Govt. of India Press, 1921. Also see, H.G. Champion, 'A Preliminary Survey of the Forest Type of India and Burma', *IFR,* (n.s), Silviculture, I(1), 1936, for a reconsideration and

elaboration of existing forest typology.

[30] E.A. Smythies, 'Sal Regeneration in United Provinces', *IF*, 58(4): 196-210, 1932, p. 199.

[31] See for instance, various essays in T.J. Barnes and J.S. Duncan, (eds), *Writing Worlds: Discourse, Text and Metaphor in the Representation of Landscape*, New York: Routledge, 1992; Stephen Daniels, *Fields of Vision and National Identity in England and the United States*, Cambridge: Polity Press, 1993; Stephen Daniels and Denis Cosgrove (eds), *The Iconography of Landscape*, Cambridge: Cambridge University Press, 1988; idem., 'Spectacle and Text: Landscape Metaphors in Cultural Geography', in J.S. Duncan and D. Ley (eds), *Place/Culture/Representation*, London: Routledge, 1993; J.S. Duncan, *The City as Text: the Politics of Landscape Interpretation in the Kandyan Kingdom*, Cambridge: Cambridge University Press, 1990. A critique of this trend is offered by Derek Gregory, *Geographical Imaginations*, Oxford: Basil Blackwell, 1994.

[33] For India, the pioneering work on colonial forestry and resistance is Ramachandra Guha, *Unquiet Woods*; a short list of other studies where resistance has been used as an index of alternate views of the forest (in itself an uninterrogated and somewhat static category) would include, Robert Anderson and Walter Huber, *The Hour of the Fox: Tropical Forests, the World Bank and Indigenous People in Central India*, New Delhi: Vistaar, 1988; Vandana Shiva, *Ecology and the Politics of Survival: Conflicts Over Natural Resources in India*, New Delhi: Sage, 1991, pp. 61-122; Madhav Gadgil and Ramachandra Guha, *This Fissured Land: An Ecological History of India*, New Delhi: Oxford University Press, 1992, chapter 5; Neeladri Bhattacharya, 'Colonial State and Agrarian Society', in Burton Stein (ed.) *The Making of Agrarian Policy in British India, 1770-1900*, New Delhi: Oxford University Press, 1992; Ajay Skaria 'A Forest Polity in Western India: The Dangs, 1840s-1920s', Ph.D thesis, Cambridge University, 1992, chapter 8; Archana Prasad, 'Forests and Subsistence in Colonial India: A Study of the Central Provinces', 1830-1945, Ph.D. thesis, Jawaharlal Nehru University, 1994, chapter 3; Nandini Sundar, 'In Search of Gunda Dhur: Colonialism and Contestation in Bastar, Central India, 1854-1993', Ph.D. thesis, Columbia University, 1994; Amita Baviskar, 'Development, Nature and Resistance: The Case of the Bhilala Tribals in the Narmada Valley', Ph.D thesis, Cornell University, 1992; Akhileshwar Pathak, *Contested Domains: The State, Peasants and Forests in Contemporary India*, New Delhi: Sage, 1994. For other parts of Asia see, Nicholas Menzies, 'Strategic Space: Exclusion and Inclusion in Wildland Policies in Late Imperial China', *MAS*, 26(4): 719-733, 1992; Raymond L. Bryant, 'Shifting the Cultivator: The Politics of Teak regeneration in Colonial Burma', *MAS*, 28: 225-250, 1994; Nancy Peluso, *Rich Forests, Poor People: Resource Control and Resistance in Java*, Berkeley: University of California Press. A notable exception to this body of work, and where the processes of ecological change penetrating political and social interventions and imaginations in forest management have been examined to some degree, is Conrad Totman, *The Green Archipelago: Forestry in Pre-Industrial Japan*, Berkeley: University of California Press, 1989.

[34] Donald Worster, *Rivers of Empire: Water, Aridity and the Growth of the American West*, New York: Pantheon, 1985; idem., 'Seeing Beyond Culture', *Journal of American History* 76: 1142-47, 1990; Carolyn Merchant, *Ecological Revolutions: Nature, Gender and Science in New England*, Chapel Hill: University of North Carolina Press, 1989; William Cronon, *Nature's Metropolis: Chicago and the Great West*, New York: W.W. Norton, 1991, pp. 56, 149-150.

[35] David Demeritt, 'The Nature of Metaphors', p. 175.

[36] NAI Rev and Agri (For), A Progs GOI 32&33, file 352 of 1904, Mar 1905, no 4969 dated Cal 24 Dec 1904, A Earle Secy GOB to the Secy GOI, p. 409; A Progs GOI 12-16, file 45 of 1901, July 1901, no 680-F dated Simla 18 June 1901, J.B. Fuller Offg Secy GOI to Secy GOB Rev, p. 1031.

[37] NAI Rev and Agri (For), A Progs GOI 41-43, file 11 of 1908, Feb 1909, GOB Res no. 5110 dated Cal 11 Dec 1908, p. 597; the discussion here of forests and climate must be seen in the context of a larger discussion generated from the Famine Commission reports of the preceding twenty years. Its relation to an older conservation discourse cannot also be missed. The nature of these older ideas of colonial surgeons and botanists are discussed in detail by Richard Grove, 'Conserving Eden', and idem, *Green Imperialism: Colonial Expansion, Tropical Island Edens and the Origins of Environmentalism, 1600-1860,* Cambridge: Cambridge University Press, 1995. Their role in late nineteenth century forest management has been assessed by Ajay Skaria, 'Timber Conservancy, Dessicationism and Scientific Forestry: the Dangs, 1840-1920', and Mahesh Rangarajan, 'Production, Dessication and Forest Management in the Central Provinces', in Richard Grove, Vinita Damodaran and Satpal Sangwan (eds). *Nature and the Orient: Essays in the Environmental History of South and South-east Asia,* Delhi: Oxford University Press, 1996.

[38] NAI Rev and Agri (For), A Progs GOI 76 & 77, file 336 of 1909, January 1910, GOB Res no. 3558 For. dated Cal 20 Nov 1909, p. 132.

[39] Notification in the Calcutta Gazette dated November 3, 1879, under section 45 ofthe Indian Forest Act 1878, demarcated the entire province of Bengal, from Darjeeling to 24 Parganas and Jessore as the area within which 'all unmarked wood and timber shall be the property of the government. ' Reproduced in *IF*, 5: 406, 1879-80.

[40] Ribbentrop, *Forestry in British India,* p. 61.

[41] Brandis, *Suggestions for Jalpaiguri and Darjeeling,* p. 19; Anon, 'Mr. Brandis's Work in Bengal', *IF*, 11(8): 349-355, 1885, pp. 349-350.

[42] Stephen Pyne, 'India's Cycle of Fire'; idem, *Fire and America: A Cultural History of Wildland and Rural Fire,* Princeton: Princeton University Press, 1982.

[43] Ibid., p. 12.

[44] William Schlich, 'Review of Forest Administration for British India', *IF*, 10(8): 372-378, p. 377.

[45] Speaking of agricultural settlement reports which began to be prepared extensively on an individual plot basis in the 1870s, David Ludden says, 'they succeeded in their most important goal, to channel copious information and thus power to define the terms of revenue transactions into urban official hands'. See David Ludden, 'Anglo-Indian Empire', in Burton Stein (ed.), *The Making of Agrarian Policy in British India, 1770-1900,* New Delhi: Oxford University Press, 1992, p. 176. The forest working plan accomplished similar things in the forest areas, though in the absence of annual cultivation and decennial renewal, as in the case of land settlements, there was no continuous arrangement to renew this information interactively with village communities. The other important aspect is that the tilling and production operations on forest land was a direct departmental effort with peasantries reduced to the role of skilled labour. This shifted expertise more completely away from local institutions to state science than in the case of agriculture.

[46] This is undertaken in my larger research project on forests, politics and governance in Bengal, 1794-1994.

[47] The following four paragraphs are based largely on the following studies of silvics and

ecology of sal done mostly in the early twentieth century. There is a larger literature, which is not all cited. It is noteworthy that in the last fifty years research on sal has reduced to a trickle, compared to the flood produced in 1900-1945. Herbert Champion, 'Regeneration and Management of Sal *shorea robusta*', *IFR* (old series), Silviculture, XIX(3), Delhi: Government of India Press, 1933; Herbert G. Champion and B.D. Pant, 'Investigation on the Seed and Seedling of *shorea robusta* gaertn.' *IFR* (old series), Silviculture, XVI(5), Delhi: Government of India Press, 1931; Herbert G. Champion and S.K. Seth, *Forest Types of India*, Delhi: Government of India Press, 1968; idem, *General Silviculture for India*, Delhi: Government of India Press, 1968; R.S. Hole, 'Oecology of Sal *shorea robusta*, Part I: Soil Composition, Soil Moisture, Soil Aeration, Part II: Seedling Reproduction in Natural Forests and its Improvement, Part III: Soil Aeration and Water Cultures', *IFR* (old series), Botany, V(4), Delhi: Government of India Press, 1914-1916; idem, 'Regeneration of Sal *shorea robusta* Forests: a Study in Economic Ecology, *IFR* (old series), Silviculture,VIII(2), Delhi: Government of IndiaPress, 1921; idem, 'Regeneration of Sal *shorea robusta* Forests', *IF*, 47(4):151-159, 1921; J.S. Samra, B.G. Dabral and K. Singh, 'Edaphic and Microclimatological Studies with Reference to Regeneration of Sal *shorea robusta*, *IF*, 111:396-404, 1985; J.S. Samra, K. Singh, S.K. Sharma and S.D. Sharma, 'Characterization of Soil Sequences in Relation to Vegetation in Kalagarh Forest Division, Uttar Pradesh (India)', *Tropical Ecology*, 26: 72-79, 1985; E.A. Smythies, 'Note on the Die-back of Sal Seedlings', *IF*, 44(9): 420-22, 1918; idem', Sal Regeneration in the United Provinces', *IF*, 90(3): 137-146, 1964, 58(4): 196-210, 1932; idem, 'Silvicultural Systems for Sal', *IF*, 46(8): 381-91,1920; idem, 'The Sal forests of Haldwani, North Kheri and Nepal', Indian Forester, 56(6): 243-50, 1930; idem, 'Sal Regeneration in the United Provinces', *IF*, 57(6): 298-301, 1931; idem, 'Seedling Regeneration in B-3 Sal', *IF*, 62(4): 186-204, 1936; idem, 'Sal and its Regeneration', *IF*, 55(9): 510-17, 1929; F.C. Osmaston, 'Sal and its Regeneration', *IF*, 54(11): 567-77; 54(12): 639-55, 1928; 55(11): 624-25, 1929; F.C. Ford-Robertson, 'The Problems of Sal Regeneration with Special Reference to the "Moist" Forests of the United Provinces', *IF*, 53(9): 500-11; 53(10): 560-76, 1927.

[48] Dietrich Brandis, *On the Distribution of Forests in India*, Edinburgh: McFarlane and Erskine, 1873, pp. 7-8.

[49] A.L. McIntire, *Notes on Sal in Bengal*, Forest Pamphlet no. 5, Calcutta: Superintendent of Government. Printing, 1909, p. 1-2.

[50] Brandis, *Distribution of Forests*, *p.* 12.

[51] Brandis, *Distribution of Forests*, *p.* 21.

[52] OIOC P/243 BRC(For), 1873-75, A Progs 10, Jan 1873, letter dated Dec 20, 1872, William Schlich, CF Bengal to Secy GOB, Rev; BFAR, 1871, para 11-42; July 1873, File 23-1, 23-2, no. 485 dated Jalpaiguri Mar 29, 1873, Capt. C.W. Losack DCF Cooch Behar to CF Bengal, p. 1415. Losack identified 30 trees in the Chota Nagpur forests.

[53] OIOC P/432/76 BRP (For), May-Aug 1869, A Progs 9, July 1869, no. 57A dated Cal 5 Feb, 1869, H. Leeds CF LP to Secy GOB, p. 12.

[54] P.N. Suri, 'Commercial Volume Tables for Sal in the Wet Mixed Forests of Bengal Duars', *IFR*, XIII(3), 1928, Calcutta: Government of India Press; WBSRR GOB Rev (For) File 5-B/10, A progs 2-4, Aug 1915, no. 882F-198-2 dated Simla 1 July 1915, F Noyce US GOI, Rev and Agri to Secy GOB Rev; no. 7432 dated Cal 30 July, 1915, J.N. Mitra US GOB Rev to CF Bengal, p. 3.

[55] R. Pearson, 'Note on Mechanical Strength and Seasoning Properties of *Shorea Robusta* timber', *IFR*, VII(6), Calcutta; Government of India Press, 1919.

[56] R. S. Troup, *The Sylviculture of Indian Trees,* Calcutta: Government of India Press, 1921; S. Rajkhowa, 'The Relative Importance of Various Tending Operations on the Early Growth and Survival of Sal Seedlings in the Eastern Terai Sal', *IF,* 90(3): 137-146, 1964.

[57] Falling partly in what became Jalpaiguri and Goalpara districts of Bengal and Assam respectively, the Duars were a strip of well forested country that was acquired from Bhutan after the last Bhutan war. Buxa was a little military station in the Duars, at an elevation of 2000 feet. Anon, 'A Visit to Kuch Behar, the Bhutan Duars and Assam', *IF,* 11(6): 251-262, 1885, p. 253.

[58] R.S. Troup, *Sylviculture,* p. 43; WBSRR GOB Rev (For), File 5-B/10, A progs 2-4, August 1915, no. 882F-198-2 dated Simla 1 July 1915, F Noyce US GOI, Rev and Agri to Secy GOB Rev; no. 7432 dated Cal 30 July, 1915, J.N. Mitra US GOB Rev to CF Bengal, p.3.

[59] M. Shaukat Hussain, 'Raising Sal Departmental Taungya in United Provinces', *IF,* 59(5): 320-21, 1933; idem, 'Artificial Regeneration of Sal by Taungya in Gorakhpur', *IF,* 53(11): 642-45, 1927; idem, 'The Development of Sal Seedlings in Gorakhpur Taungya', *IF,* 51(5): 69-72, 1925; idem, 'Suitable Field Crops for Sal Taungya in the United Provinces', *IF,* 51(5): 192-98 1925; E.O. Shebbeare, 'Sal Taungyas in Bengal', *EFJ,* 11(1): 18-33, 1932; idem, 'Northern Bengal Taungyas', *IF,* 87(11): 663-66, 1961. Hussain and Shebbeare were the main contributors to researching and propagating Sal taungya in eastern United Provinces and Bengal respectively.

[60] Troup, *Sylviculture,* observes that the eastern Himalayan bhabhar, terai, and savannah subtypes of sal forests should be regarded as the biotic sub-climax formation resulting from fire.

[61] R. Chakravarti, 'The Natural and Artificial Regeneration of Dry Peninsular Sal', *IF,* 74(2): 57-67, 1948, p. 57.

[62] Champion, 'Regeneration and Management of Sal', p. 55.

[63] Chakravarti, 'Dry Peninsular Sal', p. 58-59.

[64] The compilation of lists of trees found in the sacred groves of the Santhals, by William Archer, *The Hill of Flutes. Life, Love and Poetry in Tribal India: A Portrait of the Santhals,* Pittsburgh: University of Pittsburgh Press, 1974; and later by Mohan Gautam, *In Search of an Idendity: A Case of the Santhal of North India,* Leiden: E.J. Brill, 1977, confirms this association of mahua, peepul (rol) and sal. Other characterisitc associates of dry peninsular sal were sabai grass, and *Cliestanthus collinus.* Valley associates were *Lagerstroemia parviflora, Terminalia tomentosa, Terminalia belerica, Pterocarpus marsupium, Adina cordifolia, Eugenia jambolana, Anthocephalus kadamba* and large clumps of *Bambusa arundinacea.* On hill slopes *Dendrocalamus strictus, Disopyros melanoxylon, Bassia latifolia, Schleichera trijuga* were the chief associates. Chakravarti, 'Dry Peninsular Sal', p. 58.

[65] J.K. Ganguly, 'Artificial Regeneration of Sal and Teak', *IF,* 89(4): 272-274, 1963.

[66] Anon., *Report of the Bengal Forest Committee,* Alipore: Government Press, 1939; *First Working Plan of the West Midnapore Forest Division,* West Bengal, Alipore: Government Press, 1975, (hereafter referred to as *West Midnapore WP).*

[67] R.S. Hole, 'Useful Exotics', p. 7-8; he also pointed out the vulnerability of exotics to disease and pest attack, something that the former Bengal CF, IGF and silvicultural authority, William Schlich, was most concerned about too. See his, *Manual of Indian Forestry,* Calcutta: Superintendent of Government Printing, Vol. I, 1906, p. 139-140.

[68] Leeds, Schlich's immediate predecessor as CF Bengal, had been convinced that

plantations would be a necessary and major part of forest department activity as natural reproduction could not be relied upon to supply the growing wants of the country. OIOC P/432/75 BRP (For), JanApr 1869, A progs 1, April 1869, no. 33A dated Darjeeling 13 Oct 1868, H. Leeds CF Bengal to Secy GOB Rev, p. 12.

[69] BFAR, 1900-1938, selected years. It is important to note, as Mahesh Rangarajan, 'Forest Management in the Central Provinces', pp. 11-12, does for Central Provinces and I find in Bengal both cases of mixed, dry deciduous forests dominated by sal – that conservation in the early incarnation was directed at control of traders, rural tree and land users. With the 1878 act, exclusion of fire and cattle came to be seen as a prerequisite for forest management, and by the early twentieth century, both silvicultural wisdom and scarcity of labour for forest operations led to a series of accomodations that modified the law in practice.

[70] Dietrich Brandis, *Indian Forestry,* Woking: Oriental Institute, 1897, p. 77.

[71] Ribbentrop, *Forestry in British India,* p. 39.

[72] Hooker, *Himalayan Journals,* p. 3.

[73] E.O. Shebbeare, 'Fire Protection and Fire Control in India', *Third British Empire Forestry Conference,* Canberra, 1928, p. 1.

[74] Birdwood, *Indian Timbers,* p 26.

[75] Brandis, *Distribution of Forests,* p. 14.

[76] Brandis, *Distribution of Forests,* p. 10.

[77] OIOC P/9548 BORP (For), Jan-May 1914, A progs 4-11, March 1914, File IIIF/1, no. 1818254 dated Ranchi 17 Sep 1913 from H. Carter, CF Bihar and Orissa to Secy GOBO Rev, p. 42-43.

[78] This is well portrayed in the Jungle Books (second part), where the adult Mowgli joins the Forest Department as a guard and is assigned the duty of warning of all fires in the Rukh. See Rudyard Kipling, 'In the Rukh', *The Jungle Books,* Oxford, 1987, p. 343 .

[79] As at least one Working Plan was to confess, half the cases of illegal fire investigated, implicated protective staff. See, A.A.F. Minchin, *Working Plan for Gumsur Forests, Ganjam District,* Madras: Government Press, 1921, pp. 38-40.

[80] Dietrich Brandis, *Suggestions forJalpaiguri and Darjeeling,* p. 2.

[81] Ribbentrop, *Forestry in British India,* pp. 155-56.

[82] Brandis, *Distribution of Forests,* pp. 8-9; Birdwood, *Indian Timbers,* p. 25.

[83] Stebbing, *Forests,* Vol. III, p. 198.

[84] Brandis, *Suggestions for Jalpaiguri and Darjeeling,* p. 6.

[85] Birdwood, *Indian Timbers,* p. 25; Lt. Col. F. Bailey, 'Forestry in India', in the *Scottish Geographical Magazine,* 1897, p. 576; William Schlich, *Manual of Forestry;* S. Eardley Wilmot, *Forest Life and Sport in India,* London, 1910, p. 367, 370; Valentine Ball, *Jungle Life in India: Or the Journey and Journals of an Indian Geologist,* London: Thomas de la Rue, 1880, p. 68.

[86] OIOC P/432/65 BRP (For), Nov-Dec 1866, A Progs 4, no. 62 dated 5 Dec 1866, Anderson to Secy GOB, pp. 16-18.

[87] OIOC P/7033 BRP (For), 1905, A progs 14-16, June 1905, File 3W/9, no. 1 lWP dated Cal 23 Jan, 1905, S. Eardley Wilmot IGF GOI to CF Bengal; no. 1233T-R dated Darjeeling 15 June 1905, M.C. McAlpin US GOB Rev to CF Bengal, p. 149-155.

[88] Pyne, 'India's Cycle of Fire', p. 7.

[89] OIOC P/243 BRC (For), 1873-75, A Progs 18, January 1873, Memo dated July 4, 1872 by H. Leeds, CF Bengal.

[90] An Aged Junior, 'Some Remarks on Titles and Tigers', *IF,* 16(1-3): 182-184, 1890.

[91] OIOC P/234 BRP (For) Oct -Dec 1872, A Progs 10, Oct 1872, no. 77C dated Darjeeling 31 July 1872, Major BW Morton DC Darjeeling to Commr Cooch Behar, p. 7.
[92] 0IOC P/234 BRP(For), Oct -Dec 1872, A Progs 40, Nov 1872, no. 22 dated 19 July 1872 from H Leeds CF Bengal to Secy GOB Rev, enclosing no. 7 dated Royal Botanical Gardens 29 June 1872, George King Superintendent Botanical Gardens Calcutta to H Leeds CF Bengal, p. 28.
[93] Gadgil and Guha, *This Fissured Land,* pp. 146-180.
[94] Neeladri Bhattacharya, 'Colonial State and Agrarian Society', pp. 130-132. In 1884, Sir William Wedderburn wrote that forest degradation had arisen from disregard of old village methods of conservancy in which forest preservation had been closely integrated into the agrarian economy. See his, 'The Indian Raiyat and the Village Community', *Indian Agriculturalist,* July 12, 1884, extracted in *IF,* 10(11): 511-515, 1884. In 1903, Whittal, the Conservator of forests in Punjab recommended active involvement of villagers in the spirit of Wedderburn's suggestions. 'According to him, fire lines and fire watchmen were of little use: a vigorous enforcement of the principle of joint responsibility of villagers could provide a possible solution' quoted in Bhattacharya, 'Colonial State and Agrarian Society', p. 132.
[95] As Thompson says, these kinds of occurrences 'gave publicity to a curious kind of dialogue between the authorities and the crowd'. See E.P. Thompson, 'The Crime of Anonymity', in Douglas Hay, Peter Linebaugh, John G. Rule, E.P. Thompson and Cal Winslow (eds), *Albion's Fatal Tree: Crime and Society in Eighteenth Century England,* New York: Pantheon, p. 270.
[96] W.R. Fisher, 'Fire Conservancy in the Sal Forests ofthe Eastern Duars', *IF,* 5(4): 428-444, 1880. The extent of disruption that fire protection caused to the agrarian economy is astounding. Hunting of small mammals and micro fauna became arduous; pastures became overgrown; villagers could not move about to gather small timber for fuel or construction; tigers would use high grass in the vicinity of settlement to menace cattle; elephants, buffalos and deer would ravage crops; and lastly a fire in a contiguous forest could devastate a large area uninterrupted by open spaces.
[97] WBSA P/582 BRP (For), July 1900, A progs 1-4, File 4-A/3 -1, no. 104 dated Darjeeling 3 June 1900, A.C. Wild CF Bengal to Secy GOB Revenue, p. 3.
[98] WBSA P/582 BRP (For), July 1900, A progs 1-4. File 4-A/3 -1, no. 532C dated Singhbhum 9 Feb 1900, E.G. Chester DCF Singhbhum to CF Bengal, p. 5-6
[99] OIOC P/6794 BRP (For), Aug-Oct 1904, A progs 4-12, Sep 1904, File 3F/3, no. 473LR dated Ranchi 21 June 1904, W. Maude Offg. Commr Chota Nagpur to Secy GOB Rev; no. 313R dated Chaibassa 15 June 1904, H.F. Samman DC Singhbhum to Commr Chota Nagpur, p. 131. The use of Mankis and Mundas was not easy, quite often they gave evidence in cases of incendiarism in a way that subverted the prosecution of apprehended villagers from their jurisdiction. OIOC P/8693 BRP (For), 1911, Progs 1-4 Dec 1911, File 7F/2, no. 701R dated Chaibassa 11 August 1911, A.W. Cook DC Singhbhum to Commr Chota Nagpur, p. 4
[100] OIOC P/6794 BRP (For), Aug-Oct 1904, A progs 4-12, Sep 1904, File 3F/3, no. 3180 dated 8 Aug 1904, L.S.S. O'Malley US GOB Rev to Commr Chota Nagpur; no. 115 dated Darjeeling 28 July 1904, CF Bengal to Secy GOB Rev; no. 77C dated Chaibassa 1 June 1904, J.W.A. Grieve DCF Singhbhum to CF Bengal, p. 135-137.
[101] F. Trafford, *Working Plan (revised) for the Reserved Forests of the Jalpaiguri Division,* Darjeeling: Bengal Secretariat Tour Press, 1905, p. 19.
[102] NAI Rev and Agri (For), A Progs GOI 41-43, file 11 of 1908, Feb 1909, GOB Res no

5110 dated Cal 11 Dec 1908, p. 596.
[103] P. Tinne, *Second Working Plan for the Reserved Forests of the Tista Division*, Calcutta: Bengal Secretariat Press, 1907, p. 4.
[104] Ibid., p. 4.
[105] For a similar discussion of forest firing as resistance in the Punjab, see Niladri Bhattacharya, 'Colonial State and Agrarian Society', pp. 131-2. He does not, however, make the distinction between reserved and protected forests that is important to my analysis.
[106] A.L. McIntire, *Notes on Sal in Bengal*, p. 9; H.H. Haines, *Working Plan of the Reserved Forests of Singhbhum of the Bengal Forest Circle*, Calcutta: Bengal Secretariat Press, 1905.
[107] The silvicultural literature on sal regeneration in India, has a large debate on the use of fire. Herbert Champion, 'Regeneration and Management of Sal' provides the first comprehensive review of this literature. More recently, H.B. Joshi, *Troup's Silviculture of Indian Trees*, Dehradoon: Forest Research Institute, 1980 provides a revision and updated review of the issues. Some other important colonial writings are listed here. B. Sengupta, 'Fire Conservancy in Indian Forests', *IF*, 36(3): 132-145; W.A. Bailey, 'Sal Coppicing and Burning', *IF*, 51(8): 404-06, 1925; E.C. Mobbs, 'Sal Natural Regeneration Experiments in the United Provinces', *IF*, 62: 260-67, 1936; F.C. Osmaston, 'The Effect of Burning on Medium Quality Sal Coppice', *IF*, 61(5): 311-13, 1935; E.O. Shebbeare, 'Fire and Sal', *IF*, 56: 302-06, 1930; A.J.W. Milroy, 'Sal and Fire', *IF*, 56: 442-47, 1930. One recent article on fire and sal regeneration is G.P. Maithani, V.K. Bahuguna and P. Lal, 'Effect of Forest Fires on the Ground Vegetation of a Moist Deciduous Sal *shorea robusta* Forest', *IF*, 1 12(8): 646-77, 1986.
[108] Ribbentrop, *Forestry in British India*, p. 170.
[109] NAI Rev and Agri (For), A Progs GOI 62&63, file 51 of 1906, March 1906, no 126 dated Cal 16 Jan 1906, R.W. Carlyle Offg Chief Secy GOB to Secy GOI, p. 289.
[110] Ibid.
[111] NAI Rev and Agri (For), A Progs GOI, 56-58, file 84 of 1907, May 1907, GOB Res no. 174, dated Cal 9 Jan 1907, p. 696.
[112] WBSRR GOB Rev (For), File 9-R/l. A Progs 1-4, Feb 1908, no. 141 dated Darjeeling 27 Sep 1907, CF Bengal to Chief Secy GOB, p. 86.
[113] NAI Rev and Agri (For), A Progs GOI 43-46, File 124 of 1916, May 1916, no. 309F dated Simla 29 May 1916, AE Gilliat Offg. US GOI to Secy GOB Rev, p. 1.
[114] In Buxa, success in fire protection (measured by taking area burnt as a percentage of area protected) hovered between 50-70 percent in the period 1875-80. It rapidly improved to 90-95 percent in the next three years and by 1905 was always between 98-99 percent. See C.C. Hatt, *Working Plan for the Reserved Forests in the Buxa Division*, Calcutta: Bengal Secretariat Book Depot, 1905, Appendix V, p. xvi-xviii. Similarly, in Jalpaiguri, fire protection was 99 percent successful between 1896 and 1906. See Trafford, *Jalpaiguri WP*, Appendix VII.
[115] R.C. Soni, 'A Note on the Natural Regenaration of Sal', in *Proceedings of the All-India Sal Study Tour and Symposium*, Dehradoon Forest Research Institute, 1953, p. 47.
[116] WBSRR GOB Rev (For), File 5-B/10, A progs 9-10, Nov 1915, no. 1943-769 dated Darjeeling 13 Oct 1915; C.E. Muriel CF Bengal to the Secy GOB Rev; no. 117-64 dated Jalpaiguri 10 June 1914, E.O. Shebbeare DCF Jalpaiguri to C.E. Muriel CF Bengal; no. 11516 dated Calcutta 23 Nov 1915, L. Birley Offg. Secy GOB Rev to CF Bengal, p. 2-5.
[117] WBSRR GOB Rev (For), File 5-B/10, A progs 2-4, August 1915, no. 882F-198-2 dated

Simla 1 July 1915, F. Noyce US GOI Rev and Agri (For) to the Secy GOB Rev; no. 7432 dated Calcutta 30 July 1915, J.N. Mitra US GOB Rev to CF Bengal, p. 4; Haines, *Jalpaiguri WP;* Manson *Darjeeling WP;* Trafford *Jalpaiguri WP;* Hart *Buxa WP;* Tinne, *Tista WP;* Grieve *Darjeeling WP*. Shebbeare notes, 'the proposal to burn the forest in the hope of assisting regeneration of sal met, not unnaturally, with some opposition, especially from the older generation of foresters', E.O. Shebbeare, 'Sal Taungyas in Bengal', *EFR,* 11:18-33, 1932, p. 21.

[118] Trafford, *Jalpaiguri WP*, p. 4.

[119] WBSRR GOB Rev (For), File 5-B/10, A progs 9-10, Nov 1915, no. 1943-769 dated Darjeeling 13 Oct 1915, C.E. Muriel CF Bengal to Secy GOB Rev; no. 117-64 dated Jalpaiguri 10 June 1914, E.O. Shebbeare DCF Jalpaiguri to C.E. Muriel CF Bengal; no. 11516 dated Calcutta 23 Nov 1915, L. Birley Offg. Secy GOB Rev to CF Bengal, p. 12.

[120] The savannah grasses varied in the terai (wet, clayey) and bhabhar (dry, gravelly) areas of North Bengal Duars. While the terai had *Phagamita karka* and *Saccharum procera,* bhabhar tracts had *Saccharum narenga* (bata grass) and *Imperata arundinacea* which assisted sal regeneration. The drier areas in Jalpaiguri had *Microstegium ciliatum* in which bata grass would then come up. These savannah conditions were clearly the outcome of shifting cultivation and some of the first fire protected sal regeneration was observed in old village sites in fields with bunds and other signs of cultivation. In fire protected bhabhar sau grass, *Polinia ciliata,* was the first to invade. Sau grass gets heavy, sodden and matted on the forest floor, inhibiting sal seed from entering the soil and germinating. Firing replaces sau with bata grass, which nurses sal seeds. In the moist terai, fire protection introduced evergreen shrubs and trees like *Phylocanthus thysillorus, Viburnium colebrookium, Ammora spp, Meliosina* and *Turpinia spp* which were cemented together with luxurious climbers like *Spatholobus roxburghii, Mucuna macrocarpa* and *Croton spp.* Summing up these effects over the first 30-40 years of fire protections, Troup says, 'a change in moisture content of the soil, resulting in diminished soil aeration ... is the primary cause of the failure of sal regeneration'. Note date 5 March 1915, in WBSRR GOB Rev (For), File 5B/10, A progs 2-4, Aug 1915, no. 882F-198-2 dated Simla 1 July 1915, F. Noyce US GOI (Rev and Agri) to Secy GOB Rev, no. 7432 dated Cal 30 July 1915, J.N. Mitra US GOB Rev to CF Bengal, p. 38-42. The grasses of North Bengal sal forests are discussed by A.B. Chaudhuri, 'Principal Grasses and Grassland Habitats of Jalpaiguri Division, West Bengal', IF, 86(2): 87-91, 1960; idem, 'Common Grasses and Sedges of Kurseong, Kalimpong and Darjeeling Forest Divisions of West Bengal', *IF,* 86(6): 336-3 53, 1960.

[121] J.W.A. Grieve and E.O. Shebbeare, 'Sal Regeneration in the Duars, *IF*, 40(4): 147-154, 1914; R.S. Troup, *Sylviculture.*

[122] WBSRR GOB Rev (For), File 5-B/10, A progs 2-4, Aug 1915, no. 882F-198-2 dated Simla 1 July 1915, F. Noyce US GOI Rev and Agri (For) to Secy GOB Rev; no. 7432 dated Cal 30 July 1915, J. N. Mitra Under Secy GOB Revenue to CF Bengal. In his note of 5 Mar 1915, R.S. Troup, then the Sylviculturist at Forest Research Insititute, Dehradoon, notes that in the Duars burning does not produce unsound timber and grazing and thatch grass collection controls the undergrowth, (p. 23).

[123] WBSRR GOB Rev (For), File 5-B/10, A progs 2-4, Aug 1915, no. 882F-198-2 dated Simla 1 July 1915, F. Noyce US GOI Rev and Agri (For) to Secy GOB Rev; no. 7432 dated Cal 30 July 1915,J.N. Mitra US GOB Rev to CF Bengal, p. 7; A.K. Glasson, et al., 'Notes on Artificial Regeneration in Bengal', *IFR,* VI(4), Calcutta: Superintendent of Government Printing, 1922.

[124] WBSRR GOB Rev (For), File 4T/2, B progs 9-10, Mar 1917, no. 17C-2WP dated 28 Feb 1917, G.S. Hart IGFto Secy GOB Rev, pp. 1-2.
[125] Discussing the relative merits of a wide range of nurse crops that sal could use in taungya systems, one forester wrote, 'of all the tropical species a forester has to deal with in India, sal ... is the most puzzling'. M. Shaukat Hussain, 'Suitable Field Crops for Sal Taungya in the United Provinces', *IF*, 51(5): 192-198, 1925, p. 192.
[126] WBSRR GOB Rev (For), File 4T/2, B progs 9-10, Mar 1917, no. 17C-2WP dated 28 Feb 1917, G.S. Hart IGF to Secy GOB Rev, p. 3.
[127] WBSRR GOB Rev (For), File 5-B/10, A progs 9-10, Nov 1915, no. 1943-769 dated Darjeeling 13 Oct 1915, C.E. Muriel CF Bengal to Secy GOB Rev; no. 117-64 dated Jalpaiguri 10 June 1914, E.O. Shebbeare DCF Jalpaiguri to C.E. Muriel CF Bengal; no. 11516 dated Cal 23 Nov 1915, L. Birley Offg. Secy GOB Rev to CF Bengal, p. 13.
[128] WBSRR GOB Rev (For), File 4T/2, B progs 9-10, Mar 1917, no. 17C-2WP dated 28 Feb 1917, G.S. Hart IGF to Secy GOB Rev, p. 7.
[129] In his opening remarks to the Forest Conference in 1875 Brandis had said, 'as long as a forest is burned annually its improvement is hopeless ... fire conservancy is at present the most important task of the forest department'. D. Brandis, Inaugural remarks, in D. Brandis and A. Smythies, *Report of the Proceedings of the Forest Conference held at Simla in October 1875*, Calcutta: Superintendent of Government Printing, 1876, p. 4. In the same volume also see 'Report of Capt. Doveton on Fire Conservancy in Central Provinces'; A.T. Drysdale, 'History of Fire Conservancy in Mailghat'. For the spread of fire protection through India in the late nineteenth century see Mahesh Rangarajan, 'Forest Management in the Central Provinces'; Ramachandra Guha, *Unquiet Woods;* Ajay Skaria, 'Timber Conservancy'; Niladri Bhattacharya, 'Colonial State and Agrarian Society'; D. Brandis, *Suggestions Regarding Forest Administration in Madras Presidency, Madras:GovernmentPress*, 1883.
[130] M.J. Slym, *Memorandum on Jungle Fires*, Moulmein: Tennaserim Press, 1876, pp. 1-2. A significant sidelight that indicates the extent to which this author in recommending regular forest firing was being counter-hegemonic within the forestry establishment is the fact that his paper, when first read out at conference in Rangoon, was denied a place in the conference proceedings leading to its independent publication. It was later republished in the *Indian Forester*.
[131] D. Brandis, Report on Teak Forests of Pegu, 1856, in NAI GOI Foreign Department (Foreign Consultations), 108-111, 29 Aug 1858; D. Brandis, Suggestions Regarding the Management of Forests in Jalpaiguri and Darjeeling Districts, 1879, in NAI GOI Home, Rev and Agri (For) Progs. 98-100, 1881.
[132] Stebbing, *Forests*, Vol. III, p. 392-93; Ribbentrop the IGF from 1884-1900 was the architect of this policy, who overruled a growing critique of fire protection.
[133] H. Slade, 'Too Much Fire Protection in Burma', *IF*, 22(5):172-76, 1896, launched an attack on fire protection from Burma, where Brandis had formed his initial ideas.
[134] R.S. Troup, 'Fire protection in the Teak Forests of Burma', *IF*, 31(3): 138-146, 1905, p. 143; idem, 'Fire protection in the Teak Forests of Burma', *IF*, 31(9): 503-505, 1905.
[135] F.J. Braithwaite, 'Fire Protection in the Teak Forests of Burma', *IF*, 3 1(7): 383-85,1905; W.R. Fisher, 'Fire Protection in the Teak Forests of Burma', *IF*, 31(7): 385-87, 1905; Stebbing, *Forests*, Vol. III, p. 393; Barrington Moore, 'Notes on the Forests of Northern India and Burma', *IF*, 35(4): 213-219; idem, 'Notes on the Forests of Northern India and Burma', *IF*, 35(5): 257-262; B. Sengupta, 'Fire Conservancy in Indian Forests', *IF*, 36(3): 132-145, 1910; F. Beadon-Bryant, 'Fire Conservancy in Burma', *IF*, 33(12):

537-549, 1907, p. 538.

[136] See the discussion of North Bengal taungya later in this essay. Burma taungyas are discussed by H.R. Blanford, 'Regeneration with the Assistance of Taungya in Burma', *IFR*, XI(3), Calcutta: Government of India Press, 1925; memo dated 30 March 1925, from HR Blanford CF Working Plans Circle to E.P. Stebbing, quoted in Stebbing, *Forests*, Vol. III, p. 395. United Provinces taungyas are discussed by Shaukat Hussain, 'The Development of Sal Seedlings in Gorakhpur Taungya', *IF*, 51(2): 69-72, 1925; and B.R. Wood, 'The Artificial Regeneration of Sal in Gorakhpur', *IF*, 48(2): 55-67, 1922.

[137] P.D. Tracey, 'The Development of Forestry in Assam in the Last Fifty Years', *IF*, 82(12): 619-623, 1956; C.J. Rowbotham, 'The Taungya System in Cachar Division, Assam', *IF*, 50: 356-358, 1924.

[138] Rowbotham, 'Taungya System in Cachar', p. 356.

[139] For introduction of early burning in the Himalayan forests of Uttar Pradesh, see Ramachandra Guha, *Unquiet Woods*, Chapter 3; for similar re-thinking of fire protection and ue of fire in forest regeneration in central India, see Mahesh Rangarajan, 'Forest Management in the Central Provinces'.

[140] E.A. Smythies, 'The Sal Forests of Haldwani, North Kheri and Nepal'; Mahesh Rangarajan, 'Forest Policy in the Central Provinces, 1860-1914', Ph.D thesis, Oxford University, 1992, pp.39-67, 78-89.

[141] These details are discussed elsewhere in my work and provide the immediate historical context in southwest Bengal to the emergence of Forest Protection Committees (FPCs) and natural regeneration of sal, recreating the old controversies about fire. The important difference these days is that the arguments in favour of fire are now eloquently rehearsed by village leaders, thus bringing the discussion of scientific forestry out of the forest department and into the domain of JFM.

[142] As early as 1876-1877, Brandis had observed in a tour note from the Central Provinces, that prolonged fire protection in certain tracts had led to large quantities of wood of the less valuable kind crowding out teak and bijasal. See Dietrich Brandis, 'The Utilization of the Less Valuable Woods in the Fire Protected Forests ofthe Central Provinces, by Iron Making', *IF*, 5(2): 222-25, 1879.

[143] The concept of gregariousness refers to survival skills of woody plants in conditions of water and nutrient scarcity. The related adaptive mechanism of sal to the adversities in its habitat, is the ability to die back. The first fire often makes the sal seedling die back and develop strong root structure. This provides shoots the energy to grow rapidly in the second phase and acquire a tough bark on the young sapling that can then resist fire at the establishment stage, when fire removes the competition. This cycle can take four-five years. Similar behaviour is exhibited by oak and douglas fir in temperate zones. Eucalyptus in Australia does the same.

[144] OIOC P/243 BRC (For), 1873-75, A Progs, File 3-2/3, July 1873, no. 94C dated Dibrugarh July 10, 1873, William Schlich to Secy GOB; no. 2819 dated Cal Sep 19, 1873, Secy Rev GOB to CF Bengal, p. 103-116, p. 132; C.J. Rowbotham, 'Assam Forests', P.D. Stracey, 'The Development of Forestry in Assam'.

[145] E.A. Smythies, 'The Sal forests of Haldwani, North Kheri and Nepal'.

[146] A.J.W. Milroy, 'Sal Natural Regeneration in Assam', *IF*, 62: 355-60, 1936. The reference is to the region known as Boko in Kamrup district in lower Assam, where the first forest surveys discovered large fields of thatch grass with fleshy sal shoots, within reach of mother trees. Reservation followed by fire protection had produced a sal forest and led in good measure to the spread of the legend of sal as an obliging tree that grew

abundantly if mere fire protection was afforded.
[147] Similar recommendations came from Uttar Pradesh, where elimination of mallotus (an evergreen weed) was crucial to seedling growth. See Herbert G. Champion, 'Regeneration and Management of Sal'; E.C. Mobbs, 'Sal Natural Regeneration Experiments in the United Provinces'.
[148] E. A. Smythies, 'Sal Regeneration in the United Provinces', *IF,* 57(6): 298-301, 1931. He says, 'It is a curious but well established fact that whereas vigorous grass in an artificial plantation is an indication of probable failure, the appearance of mild grass in a natural (shelterwood) regeneration area is the first indication of possible success' p. 198.
[149] Gyan Prakash, 'Science "gone native" in Colonial India', p. 172.
[150] Michael Dove, 'The Dialectical History of "Jungle" in Pakistan: an Examination of the Relationship Between Nature and Culture', *Journal of Anthropological Research,* 48(3): 231-253, 1992, p.241.
[151] Michael Dove, ibid., has argued that the state tends to mystify and obfuscate the nature/culture relationship and this merits attention in the context of widespread forest degradation.
[152] See Michael Dove, 'The Practical Reason of Weeds', p. 182, for a fine discussion of these conflicts over trees and grasses in South-east Asia.
[153] Neeladri Bhattacharya, 'Colonial State and Agrarian Society', p. 124-125.
[154] Stebbing, *Forests,* vol II, p. 582.
[155] John Nisbet, *On Mixed Forests and their Advantages over Pure Forests,* London: Eyre and Spottiswoode, 1893, p. 3-4; Campbell Walker, *Reports on Forest Management in Germany, Austria and Great Britain, with Extracts from Reports by Mr. Gustav Mann, Mr. Ross and Mr. T. W. Webber, and a Memorandum by D. Brandis,* London: Eyre and Spottiswoode, 1873.
[156] Dieback was found to occur only in natural regeneration sal, not in taungya seedlings. Anon, 'Introduction', *Proceedings of the All-India Sal Study Tour and Symposium,* Dehradoon: Forest Research Institute, 1953, p. 3.
[157] F.C. Ford-Robertson, 'The Problem of Sal Regeneration', p. 507.
[158] M.D. Chaturvedi, 'Seasonal Growth of Sal Seedlings, *IF,* 57(6): 276-281, 1931; E.A. Smythies, 'Note on the Die-back of Sal Seedlings', *IF,* 44(9): 420-422, 1918. The fire before seed fall provides clean ground for seed to germinate and seedlings to strike root, by eliminating competition from weeds.
[159] R.S. Hole, 'Oecology of Sal', *IFR,* V(4), Calcutta: Superintendent of Government Printing, 1916, p. 42-70; idem, 'The Regeneration of Sal Forests: A Study in Economic Oecology', *IFR,* (old series), silviculture, VIII(2), Calcutta: Superintendent of Government Printing, 1921; idem, 'Regeneration of Sal *Shorea Robusta* Forests', *IF,* 47(4): 151-159, 1921; F. C. Ford-Robertson, 'The Problems of Sal Regeneration'; F.C. Osmaston, 'Sal and its Regeneration'; E.A. Smythies, 'Sal and its Regeneration'.
[160] E.A. Smythies, 'The Problem of Sal Regeneration', *IF,* 52: 395-400, 1926.
[161] Champion, 'Regeneration and Management of Sal'; Smythies, 'The Sal Forests of Haldwani, North Kheri and Nepal.'
[162] Champion, 'Regeneration and Management of Sal.'
[163] McIntire, *Notes on Sal in Bengal,* p. 6. For selection felling the minimum prescribed diameter was 2 feet, that is, a girth of 6 feet.
[164] OIOC P/11712 BRP(For), 1928, A progs 20-24,-April 1928, File 9R/19 of 1927, no. 5191/R-53 dated 26 Sep 1927, E.O. Shebbeare CF Bengal to Secy GOB Rev, p. 39.
[165] Stebbing, *Forests,* Vol. IV, p. 84-86; the work of R.S. Hole and E.A. Smythies initially,

and the supplementary research of a host of other field foresters had been the basis for moving into the shelterwood compartment system, notably, R.S. Hole, 'Regeneration of Sal Forests, *IF*, 45: 119-132, 1919; Smythies, 'The Problem of Sal Regeneration'; F.K. Makins, 'Natural Regeneration of Sal in Singhbhum', *IF*, 46: 292-296, 1920; W.A. Bailey, 'Moribund Forests in United Provinces', *IF*, 50: 188-191, 1924; FC Osmaston, 'Sal and its Regeneration'; J.N. Sen and T.P. Ghose, 'Soil Conditions Under Sal', *IF*, 51(6): 243-253, 1925; Ford-Robertson, 'The Problem of Sal Regeneration.'

[166] Anon, 'The Report of the Sal Study Tour', *IFR*, XIX (3), 1934; E.A. Smythies', Sal Regeneration de novo',*IF*, 66(4): 193-199, 1940; W.D.M. Warren, 'Sal Regeneration de novo', *IF*, 66(6): 334-340, 1940; E.W. Raynor, 'Sal Regeneration de novo', *IF*, 66(9): 525-529; W.D.M. Warren, 'Sal Regeneration de novo in B-3 Sal', *IF*, 67(3): 116-123, 1941; R.N. De, 'Sal Regeneration de novo', *IF*, 67(6): 283-291, 1941; A.L. Griffith and R.S. Gupta, 'The Determination of the Characteristics of Soil Suitable for Sal', *IFB*, Silviculture (new series), no. 138, 1948.

[167] Osmaston, 'Sal and its Regeneration.'

[168] Osmaston, 'Sal and its Regeneration', p. 643.

[169] Ibid., p. 648-654.

[170] Smythies, 'Sal and its Regeneration', p. 514-15.

[171] Osmaston, 'Sal and its Regeneration'; M.D. Chaturvedi, 'The Regeneration of Sal in United Provinces', *IF*, 57(4): 157-166, 1931; D. Davis, 'Sal Regeneration Fellings', *IF*, 57(4): 153-157, 1931, p. 154-55; P.D. Stracey, 'A Short Note on Uncovering Sal Regeneration in Grass in the Goalpara Forest Division, Assam', *IF*, 57(10): 513-515, 1931.

[172] Anon, 'Introduction', *Proceedings of the All-India Sal Study Tour*, p 4-5.

[173] D. Davis, 'Sal Natural Regeneration in United Provinces', *IF*, 70(1): 1-5, 1944; idem, 'Sal Natural Regeneration in United Provinces', *IF*, 74(2): 50-56, 1948, pp. 53-55.

[174] Ford-Robertson, 'The Problem of Sal Regeneration', pp. 508-509.

[175] Chaturvedi, 'The Regeneration of Sal', pp. 158-160.

[176] Ford-Robertson, 'The Problem of Sal Regeneration', pp. 562-564; R.S. Hole, 'The Oecology of Sal.'

[177] NAI GOI Education, Health and Lands (For), A progs, File 22-4/41 - F&L, 1941, no. 14803/40-IV-130 dated Nov 14, 1940, S.H. Howard President FRI to Secy GOI, pp. 6-7.

[178] *Proceedings of the All-India Sal Study Tour and Symposium*, Dehradoon: Forest Research Institute, 1953; *Proceedings of the All-India Teak Study Tour and Symposium*, Dehradoon: Forest Research Institute, 1953.

[179] R.S. Troup, *Sylviculture of Indian Trees;* R. Chakravarti, 'The Natural and Artificial Regeneration of Dry Peninsular Sal'.

[180] Similar practices, fertilising fields with burnt forest biomass, have been discussed by Skaria for the Dangs. See *A Forest Polity in Western India*, chapter 5.

[181] M.A. Waheed Khan, H.P. Bhatnagar and A.C. Gupta, 'Physiological-Ecological Studies on Sal', *Proceedings of the Tenth Silvicultural Conference*, Dehradoon: Forest Research Institute, 1961, p. 120-126; S.K. Seth and H.P. Bhatnagar, 'Indicator Species for Sal *shorea robusta* Natural Regeneration', *IF*, 86(9): 520-530, 1960.

[182] Smythies, 'Sal Regeneration in United Provinces', p. 201-202; A.J. Milroy, 'The Relations Between Sal Forests and Fire', *IF*, 56(10): 442-447, 1930, p. 442.

[183] A recent, fascinating study of the forest-savannah transition zone in Guinea has made the same point. It details the various reasons why villagers actively produced forest

islands, amidst swampy fields and savannah uplands. See Fairhead and Leach, 'Reading Forest History Backwards', pp. 57-63.

[184] E.A. Greswell, 'The Constructive Properties of Fire in *Chir pinus longifolia* Forests', *IF*, 52: 502-505, 1926.

[185] Several examples of the voluminous literature generated on sal and teak have been noted in this paper. For anjan, see, D. Witt, 'The Silviculture of Hardwickia Binata', *IFR*, II(3), Calcutta: Government of India Press, 1911.

[186] D.M. Smith, *The Practice of Silviculture*, New York: John Wiley, 1986; P.M.S. Ashton, 'Seedling Response of Shorea Species across Moisture and Light Regimes in a Sri Lankan Rain Forest', Ph.D thesis, Yale University, 1990.