technology. The technological breakthrough in weather forecasting, timely early warning, high resolution hazard and vulnerability mapping and management of big data for swift decision-making bring new hope. Some of the exciting possibilities are introduced below.

As meteorological forecasts are becoming more accurate, soon enough it should be possible to even modify the weather for dealing with disasters such as drought and forest fires. In February 2016, Uttarakhand suffered from forest fire for over 88 days, destroying 3000–8000 acres of land. Rather than waiting for rainfall to extinguish the fire, Uttarakhand should have taken recourse to cloud-seeding technology to convert clouds into giant sprinklers. In 2008, Los Angeles County officials used silver iodide to seed clouds over the San Gabriel Mountains to ward-off fires. The same year, China employed cloud-seeding technology to bring some rain and clear the air before the Beijing Summer Olympics.

Unmanned Aerial Vehicles (UAVs) including drones are also finding applications in disaster management, and Uttarakhand can immensely benefit from their effective use, especially for real-time mapping, video-filming, damage assessment and monitoring of the progress of remedial works.

Thanks to the National Remote Sensing Centre, every disaster victim from Uttarakhand can now be empowered to report his/her location, situation and send photographs to a Command Centre. The data can then be collated, analysed, classified and posted on big screens for everyone to see in real time and respond. Empowered and trained people will be able to generate instant maps and effectively communicate as never before. This would be one of the most cost-effective ways for the Government to locate and rescue stranded tourists and pilgrims.

It is time Uttarakhand promotes a two-way communication between victims and the Command Centre to ensure prompt access to the nearest safe heavens, hospitals and public utilities. The Indian Railway Management Applications make it possible to report first-hand information, videos and photographs which helps disaster-scenario-building in GIS environment. The volume, veracity, velocity and variety of big data can be managed in the times of peace for easy retrieval in the times of crisis. Next time when floods destroy bridges and landslides destroy roads in different parts of Uttarakhand, it should be possible to instantly recall all the related information for improved decision-making. Technology now enables us to fix landslides permanently.

There are numerous other examples to illustrate that simple ideas have cracked difficult problems. British paramedic Bob Brotchie showed that it is possible to identify and report causalities in the aftermath of a disaster. As far back as 2005, Brotchie had asked every smartphone user to store telephone numbers of those whom they would like to be contacted in the case of emergency. The new generation of smart phones is able to retrieve information even from locked cell phones.

Effective switch-over to intelligent transportation systems, telecommunication networks, vehicular ad hoc networks, and mobile and cloud computing technologies too will make a world of difference in disaster prevention and response, provided effective networking, multi-institutional coordination and cyber security could be ensured. By introducing community-based traffic applications, the drivers can now share real-time data on traffic flow, road accidents, disaster-related information and suggested rerouting and locate the nearest safe parking. Also, by field instrumentation and monitoring it is possible to ensure the safety of evacuation areas, police, and fire stations and hospitals.

Given the political will, clear mandate, functional institutional mechanisms, adequate resources and holistic, multi-disciplinary approach with the long-range strategy in view, Uttarakhand has the potential to bounce back to the culture of safety within the next decade.

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R. K. BHANDARI

Forum on Engineering Interventions for Disaster Mitigation,
Indian National Academy of Engineering, Gurgaon 122 018, India
e-mail: rajmee@yahoo.com

Unique pollen reception in *Tephrosia purpurea* (Linn.) Pers., a tropical weed of family Papilionaceae

Flowering plants display a spectrum of breeding systems ranging from obligate xenogamy practiced by dioecious and self-incompatible taxa, to strict autogamy in species with cleistogamous flowers[1,2]. Studies done on related species in different genera and families clearly depict selfing to be a derived condition[3]. The reason for this includes assurance of seed-set, particularly in conditions of pollen or pollinator limitations[4–7]. Several features are known to facilitate this transition from out-crossing to selfing, recent addition to which is the unique stigma and stylar movements.

Many legumes practice selfing which is mediated by the close proximity of sex organs and their nearly simultaneous maturation[8–11]. Here we report an interesting mechanism imposing selfing in a patchy legume weed, i.e. *Tephrosia purpurea* (Linn.) Pers. belonging to the Papilionaceae family. The plant forms isolated, small populations of 1–20 individuals in subtropical, dry and sandy wastelands of the Kandi belt, Jammu Province, Jammu & Kashmir (J&K), India (34.44°N, 74.54°E). Flowering and fruiting of this species span a period of 5–6 months (April to October) when temperature in the area ranges from 25°C to more than 45°C.

Though a weed, *T. purpurea* forms an important ingredient in several herbal medicines prescribed for diseases of the stomach, heart, liver, lungs, skin, blood, and even diabetes and cancer[12–16]. *T. purpurea* is a small, profusely branched, perennial herb attaining an average height of 20 cm; branches spreading, each bearing 2–8 stipulate, imparipinnate, compound leaves with 5–15 oblanceolate leaflets. The flowers are borne on terminal as well as leaf-opposed racemes, each bearing an average of 15 flowers. Individual flower is typically papilionaceous; the pistil consists of a long, linear ovary bearing a single row of ovules attached to a marginal placenta, a slightly bent flattened style and a stigma bearing prominent, long, single-celled hairs extending well beyond its surface (Figure 1 *a*). Stigma is wet, producing copious exudates at the time of receptivity.

T. purpurea takes 8–10 days for transition from bud to a mature open flower; opening is marked by the appearance of a slit through which pink-coloured petals are slightly visible. This occurs between 9.30 h and 11.30 h on bright sunny days and proceeds up to 13.00 h on hazy days. The species is protogynous with stigma receptivity commencing in a bud of around 6 mm size, approximately two days before the flower opens. At this time the stigma and a part of the style are above the level of the anthers (Figure 1 *b*). This relative position is maintained even at the time of anther dehiscence, which occurs during morning hours, i.e. between 8.00 and 9.00 h, one or two hours before the flower finally opens. The average length of pistil and stamens at this time is 7.5 and 6.3 mm respectively.

Since stigma in the mature bud outreaches the level of dehiscing anthers (pistil being 1.2 mm more in length), dusting of pollen on the self-stigma is not possible. In these buds, stigma along with style, is seen to recurve and bend over the anthers (Figure 1 *c*). The ready-to-open buds reveal a strongly bent stigma almost curled inwards and downwards accompanied by a style bent at an angle <90° with respect to the ovary, thereby making it feasible for the stigma to come in direct contact with the dehiscing anthers and get adpressed with them to capture pollen. Prior to this, the anthers within the mature bud come close together and lie below the style and stigma (Figure 1 *d*). As the anthers dehisce by longitudinal slits releasing a large amount of pollen, the same gets entrapped in the long-extending stigmatic hairs and copious exudates present on the stigma at this time (Figure 1 *f*). The style also gets a heavy pollen load all over its surface (Figure 1 *h*). By the time the flower opens, the stigma is heavily loaded with self-pollen; it now starts retracting (Figure 1 *f*) and gradually both stigma and style straighten up (Figure 1 *h*). Thereafter, stigma as well as style are seen to be straight. Postures recorded at different developmental stages of the bud have revealed the stigma bending downward to reach the dehiscing anthers below (Figure 1 *a–d*), adpressing with them to capture pollen (Figure 1 *e*), then retracting and exhibiting a column of sticky pollen mass drawn between the stigma and the dehisced anthers (Figure 1 *f*).

Observations made on young buds of different sizes revealed movement of both stigma and style. In a bud of about 4 mm size, the style is seen as a straight structure on the ovary, whereas the stigma which is initially straight (Figure 1 *a*), is seen curling downwards and inwards. Two days later when the bud is about 6 mm long, the style also exhibits curvature which gradually increases as the bud grows further. The angle between style and ovary in a ready-to-open bud is seen to be <90°. At the same time, stigma bends further and almost curls inwards with long stigmatic hairs directed downwards. Simultaneously enormous exudates gather on the stigmatic surface (Figure 1); and then it makes direct contact with the anthers to capture pollen (Figure 1 *e*). Fascinating postures with stigma nearly touching the anthers are seen in the observations made at this stage (Figure 1 *b–d*). The keel opens when the stigma is retracting. The species is visited by a few insects at this stage, but no pollen was seen sticking to their bodies. The floral visitors recorded include: alkali bee *Nomia* spp.; potter wasp *Sceliphron* spp. and common moth (unidentified).

T. purpurea has good reproductive output both in terms of fruit-set and seed-set. The fruit-set in open-pollinated and bagged flowers turn out to be 80% and 77% respectively, while seed-set in the respective flowers was estimated as 63% and 67%. The events of pollination and comparable fruit-set and seed-set in open-pollination and bagging indicate strict autogamous nature of the species.

Selfing in this species seems to be derived as the flower possesses features that could favour out-crossing. It is both protogynous and herkogamous. As anthers are below the level of the stigma, direct dusting of pollen on the stigma is not possible. Also, as the stigma attains receptivity one or two days before anther dehiscence, cross-pollination could have been possible.

The prevalence of this unique type of autogamy in the species could have arisen due to ecological conditions under which the plant grows and reproduces. The flowering period of this species is at a peak during hot summer months, when temperature generally exceeds 45°C. The high temperature prevailing during this period as a whole and the time of

Figure 1. Stages of pollen capture in *Tephrosia purpurea* (***a–d***) before, (***e***) during, and (***f–h***) after pollen capture by the stigma; bar = 1 mm.

anthesis (9.30–11.30 h) in particular, become restricting factors for the availability of pollinators. This is in all probability, accounts for such an adaptation, whereby the stigma has resorted to a fascinating mechanism to capture self-pollen and assure seed-set.

Thus *T. purpurea* becomes another addition to the species exhibiting movements of stigma and style. Previously some species of *Alpinia*, *Valeriana. Grewia* and *Ajuga* have been reported to exhibit this phenomenon. Flexistyly has been demonstrated in two species of *Alpinia – A. blepharocalyx* and *A. kwangsiensis* (family Zingiberaceae). The former displays stylar movements to facilitate pollen transfer between floral morphs, whereas the latter exhibits the same as a regular feature[17,18]. *Valeriana wallichii* (family Valerianaceae) has also been reported to exhibit such mechanism. This plant species is normally an out-breeder, but when cross-pollen is not available, it resorts to autogamy which is facilitated by curvature movements displayed by the style[19]. Wani *et al.*[20] have reported stigmatic flexing in *Grewia asiatica* (family Malvaceae), which deploys this mechanism for delayed autogamy when cross-pollen is not available. Likewise, Ganie *et al.*[21] have reported this mechanism in *Ajuga bracteosa* (family Lamiaceae), which practices autogamy favoured by stigmatic flexing.

The mechanism of flexistyly in *T. purpurea* is slightly different from the species mentioned above. It displays stigmatic as well as stylar curvature, thereby exhibiting both flexi-stigma and flexistyly. Also, the column of sticky pollen mass entrapped in the stigmatic exudates and especially the long, extending stigmatic hairs capturing self-pollen with great efficiency, make it a unique case.

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VEENA KUMARI
NAMRATA SHARMA*

Department of Botany,
University of Jammu,
Jammu 180 006, India
**For correspondence.*
e-mail: phyllanthus@rediffmail.com

Aeromonas caviae CSB04, a causal organism of bacterial flacherie in muga silkworm (*Antheraea assamensis* Helfer)

Muga silkworm, *Antheraea assamensis* Helfer is an indigenous golden silk producing lepidopteran insect endemic to Assam and adjoining north eastern states of India[1]. The silkworm is generally reared outdoor and is thus prone to various infections caused by microorganisms[2]. Bacterial flacherie is one of those diseases rapidly inhibiting the growth of the industry leading to an indiscriminate loss to native farmers of the region. Although many reports are available on the causal organisms of this particular disease, pathogens of human origin may also prove severe in this regard. An attempt has been made to detect the presence of Aeromonads in the gut of flacherie-infected muga silkworm.

Aeromonads are a group of gamma proteo-bacteria belonging to the family Aeromonadaceae. They are mostly rod-shaped, Gram-negative facultative anaerobe and are ubiquitous in all microbial biosphere[3] which includes aquatic habitats, mammals, human, fish, foods, domesticated pets, invertebrate species, birds, ticks, insects, natural soils, etc. According to Janda and Abbott[4], almost 85% of this genus is prone to a majority of human gastrointestinal infections. Although studies have been made worldwide, the factors responsible for its virulence are unknown. However, Sahu *et al.*[5] suggested the lethal effect of homeolytic and proteolytic toxins secreted by the bacteria. Hence, the presence of these bacteria in some economically important insects may also be a major threat to biodiversity.