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SHIFTING HERBIVORY PATTERN DUE TO CLIMATE CHANGE: A CASE STUDY OF HIMALAYAN BALSAM FROM PAKISTAN

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Abstract

Pests, diseases and weeds cause significant impact on crops and natural vegetation each year. Climate change is likely to cause a spread of tropical and sub-tropical species into temperate areas and to increase the numbers of many temperate species currently limited by low temperatures at high altitudes. The potential expansion of geographical ranges of pest species will be disruptive to quarantine barriers and is likely to result in increased damage to crops and natural vegetation in previously pest free areas. Elm Leaf Beetle *Pyrrhalta luteola* (Mueller) is been reported to increase due to 0.3°C rise in temperature and 3-4% decrease in rainfall in the Moist Himalayan Forest of Pakistan. The insect attacks *Impatience gladulifera* Royle., a plant of medicinal importance. The plant is not only used in a variety of local medicines but is also one of the important constituent of undergrowth natural vegetation in these forests. During the last 10 years the leaf damaged cased by the insect is on a hike and has increased up to 85%.

Introduction

Balsaminaceae is a family represented by 2 genera and over 900 species. It is distributed in Europe, N. America, Africa and Asia (Willis, 1973; Mabberley, 1987). Pakistani Balsaminaceae is represented with a single genus, i.e., Impatiens with 12 species (Nasir, 1980). This family is mainly found in highlands ranging from 4000-12000feet. *Impatiens glandulifera* Royle. (Syn. *Impatiens roylei* Walp.) and *Impatiens brachycentra* (Kar. &. Kir.) B. Fedtsch. are the most abundant member of this family and are distributed through the highlands of the country. Both of these species love water and found near stream and river beds (Nasir, 1980).

Impatiens glandulifera Royle. Commonly known as Himalayan Balsam, is a large annual plant, native to Western Himalayas- common from Pakistan to Uttar Pradesh. In Pakistan it is present in Swat. Murree Hills, Galliat, Kashmir, Astore & Chilam valleys ranging from 6000-10000 feet (Dickore & Marchus, 2000). It grows to 1 to 2 m in hight, with a soft green or red-tinged stem, and lanceolate leaves. The flowers are pink, with a hooded shape, 3-4 cm tall and 2 cm broad; the flower shape has been compared to a Policeman's helmet, giving rise to the alternative common name "policeman's helmet". It flower from July to August, and the seeds ripen from September to October. In its native range it is known with different names e.g., in Chilam valley it is known as *Fotongi* while in Kaghan valley it is named as *Bhantil* and in Murree hills it is famous as *Koindaro.* Himalayan balsam is locally used as an expectorant and treatment of Asthma. Decoction of leaves of this plant is used for cough relief in Astore and Deosai **(**Hakeem Muhmaad Issa pers. Comm.). Seeds of this plant are edible and its flavor is famous in young ones. People with a tendency to rheumatism, arthritis, gout, kidney stones and hyperacidity should take especial caution if including this plant in their diet (Bown, 1995). Young leaves and shoots are cooked. Oil from the seed is used for lighting **(**Kunkel, 1984).

Himalayan balsam was introduced in England in 1839 as garden pant where it escaped to the wild and now has got a status of an alien invasive species in United Kingdom (Tanner *et al*., 2008). This weed has also established in 23 European countries, 10 states in the USA, parts of Canada and New Zealand (Anon., 2004). In UK this plant grows on riverbanks and waste places where its dense population out compete the native vegetation and riverbanks are exposed to erosion (Hulme & Bremner, 2005).

The main objective of the present study was to collect data on increased herbivory on *Impatiens glandulifera* during the past decade in Ayubia National Park. Further survey were conducted in two other native ranges of the plant to supplement the results.

Materials and Methods

The data on which this paper is based have been collected from three different mountainous regions of Pakistan namely Ayubia National Park, Kaghan Valley and Gilgit Valley.

Ayubia National Park: Ayubia National Park is situated at a height of 8,500 ft. The adjacent areas include Murree Hills, Khera Gali, Dunga gali, Mukshpuri, Meeranjani, Baragali, Nathiagali, Kuza gali, Murree proper Ghora gali and New Murree (Patriata). The data was mostly collected from *Ayubia National park, Donga Gali* and *Chashma village* (N-35' 07 -21.9" E- 75.02' -30.7"). The data was collected over a period of 11 years from 1997 to 2008. The leaf damage was recorded as a percentage of the total leaf area. The readings were taken recording the total leaf area subtracting the area damaged by the insect on a cm graph paper. The data for precipitation and temperature was obtained from Meteorological Department, Government of Pakistan.

Astore and Chilam (Gilgit) valleys: This exploratory survey was conducted during May 2008 to record herbivory pressure on *I. glandulifera* from Astore and Chilam Valleys Gilgit. Astore (7000-10500 ft) is a beautiful valley some 110 KM from Gilgit. Alpine pastures and forests surround the Ramma Lake (3,150m), which reflect the image of Nanga Parbat (The killer mountain). Chilam is another beautiful village Astore, it is

the starting point of Deosai, the world's highest plains. *Impatiens glandulifera* was found associated with a seasonal stream at Kharam near Chilam village (10300 ft, N-35' 07 -21.9" E- 75.02' -30.7")

Kaghan valley: The second phase of this work was to target lower heights of northern areas which mainly include Kaghan & Naran valley of North West Frontier Province (NWFP). Himalayan Balsam was found growing near the river *Kunhar* at (8300ft, N-35' 07 -21.9" E- 75.02' -30.7"). Impatiens species was generally found growing near the moist and shady places especially associated with *Vibernum* and *Artmimisa* thickets near the river and stream banks (Fig. 1).

Fig. 1. A: Dense populations of Impatiens emerging around the stones of a seasonal stream near Chilam valley, Astore; B: Impatiens collection near Chilam valley Astore; C: a scenic view of Murree Hills; D: Hill top view of Kaghan valley; E: A beautiful lake view near the Astore valley; F & G: Association of Himalayan balsam with *Vibernum* and *Artimissia* species in Kaghan valley.

Result

Pakistan lies on the western margin of monsoon region and *Khanspur* and surrounding areas lie in the climate division of sub-tropical continental highlands. Notably, the Himalayas play a very vital role in the checking the monsoon disturbance coming from the Bay of Bengal. This area is very famous for its pleasant weather due to its location in the unique climate zone of northern Pakistan.

The mean monthly temperature in this area varies between –0.2°C to in January and 25.4°C in June. It is the wettest part of the country with more than 1700 mm of mean annual precipitation in form of rainfall and snow. The high amount of precipitation has given it a good cover of vegetation. The bulk of precipitation is received during the monsoon in July and august. The average rainfall is 100 inches. In winter, snow falls above an altitude of 1200 meters. The snow persists above 1800 meters elevation during January and February, especially on cooler northern slopes the hiss generally an average of about 1.25 meter of snow annually. However occasionally average annual snowfall exceeds 2.5 meter. Changla Gali gets the maximum footage of snowfall in the area (Table 1).

Table 1. Seasonal climatic data of Khanuspur and adjacent areas.

Month	Temperature extremes		Rainfall	Wind	Humidity at	
	Max. (°C)	Min. (°C)	Heaviest fall in 24 hours (mm)	Speed past 24 hours (Knots)	0300 G.M.T. (%)	1200 G.M.T. (%)
January	18	-11	98.6	7.1	64	64
February	22	-12	107.9	6.8	61	62
March	26	-07	163.6	6.6	54	58
April	29	-02	100.6	6.3	43	45
May	35	03	101.6	6.2	40	38
June	35	06	126.7	5.3	48	40
July	35	08	254.8	4.4	79	74
August	31	08	211.1	4.2	85	83
September	28	05	204.5	4.4	68	68
October	26	00	95.5	4.7	49	51
November	25	-03	98.3	4.7	40	46
December	21	-07	107.9	6.0	50	54

Source: Pakistan Meteorological Department

In and around Ayubia National Park, Himalayan balsam has been found very commonly throughout the area but was abundant near the streams and seasonal water courses.

Results from the decade long study of the herbivory on *Impatiens glandulifera* have shown that Elm Leaf Beetle *Pyrrhalta luteola* (Mueller) has become an aggressive pest increasing the leaf damage up to 85% (Fig. 2-5). *P. luteola* has been reported as a potential herbivore feeding on *Impatiens glandulifera* during the months of May to August. Maximum herbivory (85%) was recorded during July to August. The number of insects at this time rises up to 3-4 individuals per cm2. This herbivory pressure has significantly lead to an enhanced plant mortality. The reduction in precipitation of 3-4% and an increase in temperature of 0.3°C during these years seem to be a potential cause of the phenomenon.

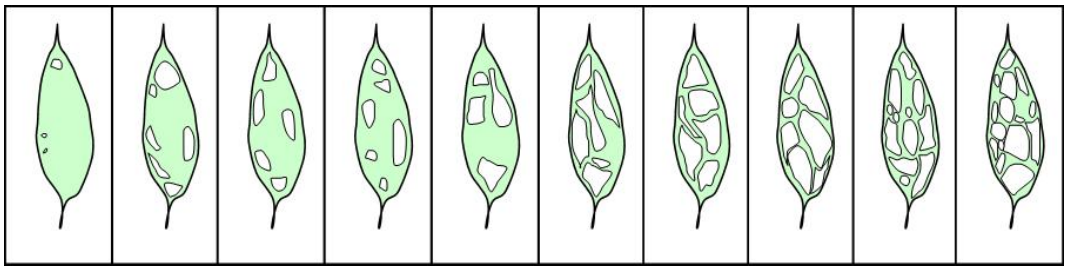

Fig. 2. Leaf damage scale showing a minimum to maximum damage.

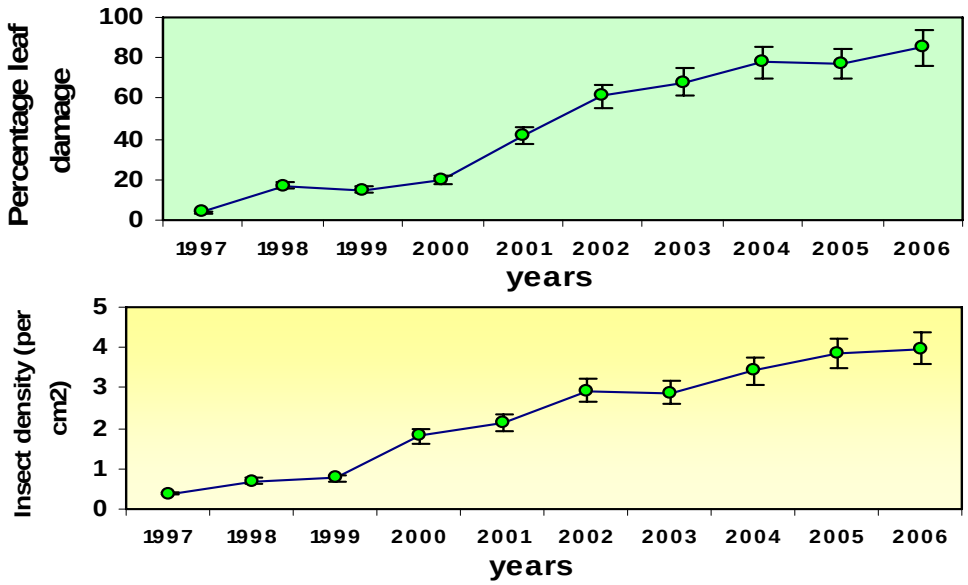

Fig. 3. Percentage of leaf damage (A) Insect density over the period of time (B).

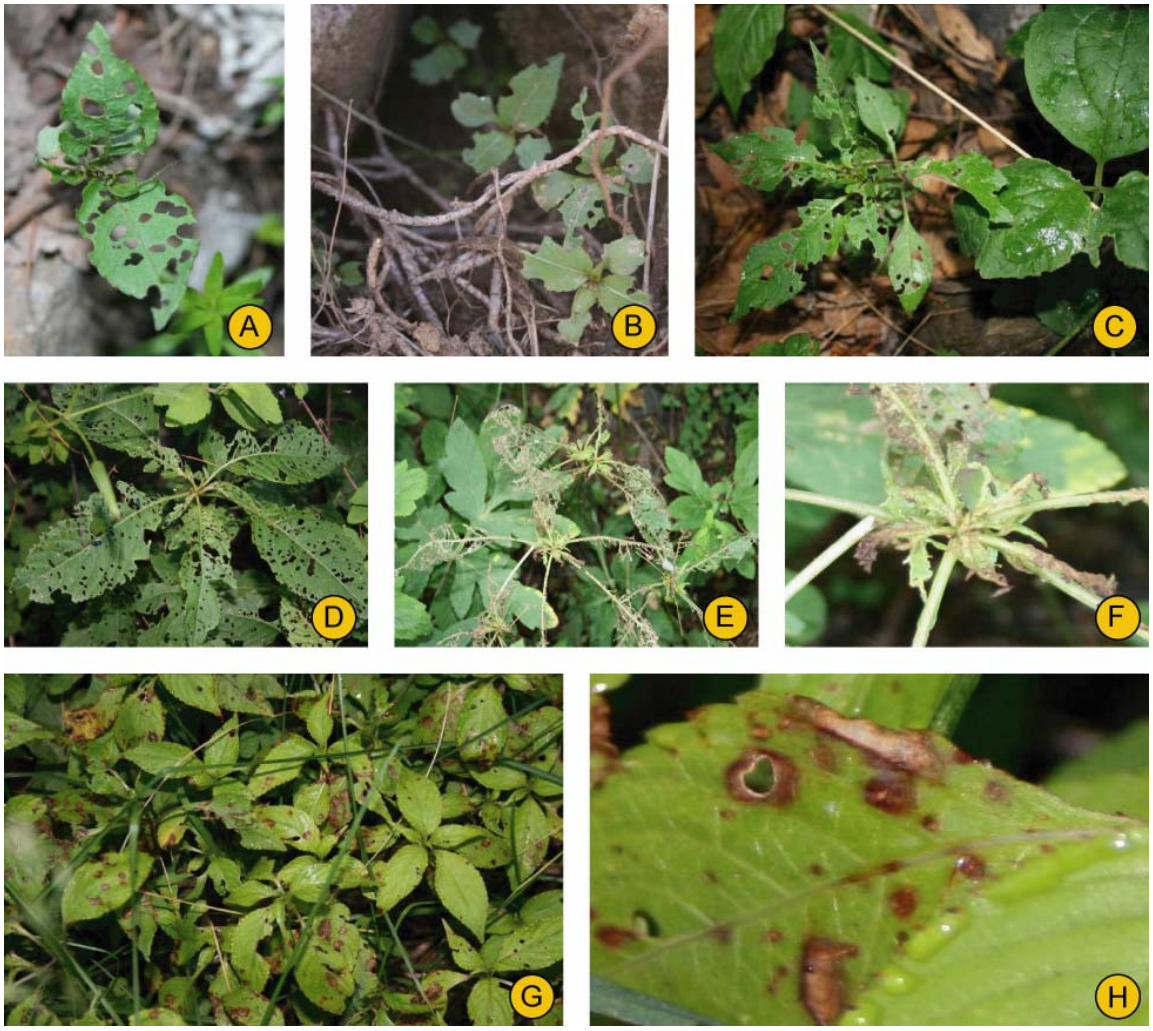

Fig. 4. A-D: Insect attack at various growth stages of Himalayan balsam. Insect larvae attack near Nathia Gali, Ayubia; G&H: *Phoma exiguina* attack at pre-flowering stage of Impatiens

Latest visit to same area was made in late June 2008 and Himalayan balsam was found in typical riparian habitat near the Nathia Gali (9,000ft) *Pyrrhalta luteola* (Mueller) infestation and damage was low but another insect was found associated with a significant defoliation effect. This insect was in larval stage and was only associated with Impatiens plants near Governor's House, Nathia Galli. The damage was so severe that insect had eaten up everything except leaf mid-rib and some veins. The insect is yet to be identified but looks very promising for biocontrol in non-native ranges.

In Astore, Gilgit Valley, it was found growing in a 2- to 4-leaf stage and was associated with large stones. Dried stalks of this plant confirmed the growth of previous year its presence in this site. Some yellow brown spots were observed on cotyledonous leaves and lower stem but could not be confirmed due to contamination problem.

Throughout Kaghan valley region an interesting insect (*Pyrrhalta luteola* Mueller) attack was found consistently at all stages (Seedlings to Flowering) of this plant.

Discussion

In the present study the case of shifting of herbivory pressure has been presented for a beetle *Pyrrhalta luteola*. The beetle exclusively feeds on a plant species *Impatiens glandulifera*, commonly known as Himalayan balsam. This plant is a native of certain high altitudinal areas of Pakistan. However, there is a growing interest in the western world to find potential biocontrol agent of this plant in view of the alien aggressive status of the plant in United Kingdom.

In this relevance for the first time Robert Tanner and Harry Evans (CABI, UK) conducted a survey of Kaghan valley for collection natural enemies on Himalayan balsam in July 2006. This survey proved highly productive in terms of identification of certain natural enemies of the Himalayn balsam (Tanner *et al.*, 2008). Most important insect was beetle *Altica himensis* with potential to be released as biocontrol agent. However they collected many other insects belonging to different orders. Similarly a rust *Puccinia argentata* was also isolated from Himalayan balsam but lab studies didn't confirm infection to British biotypes of Impatiens.

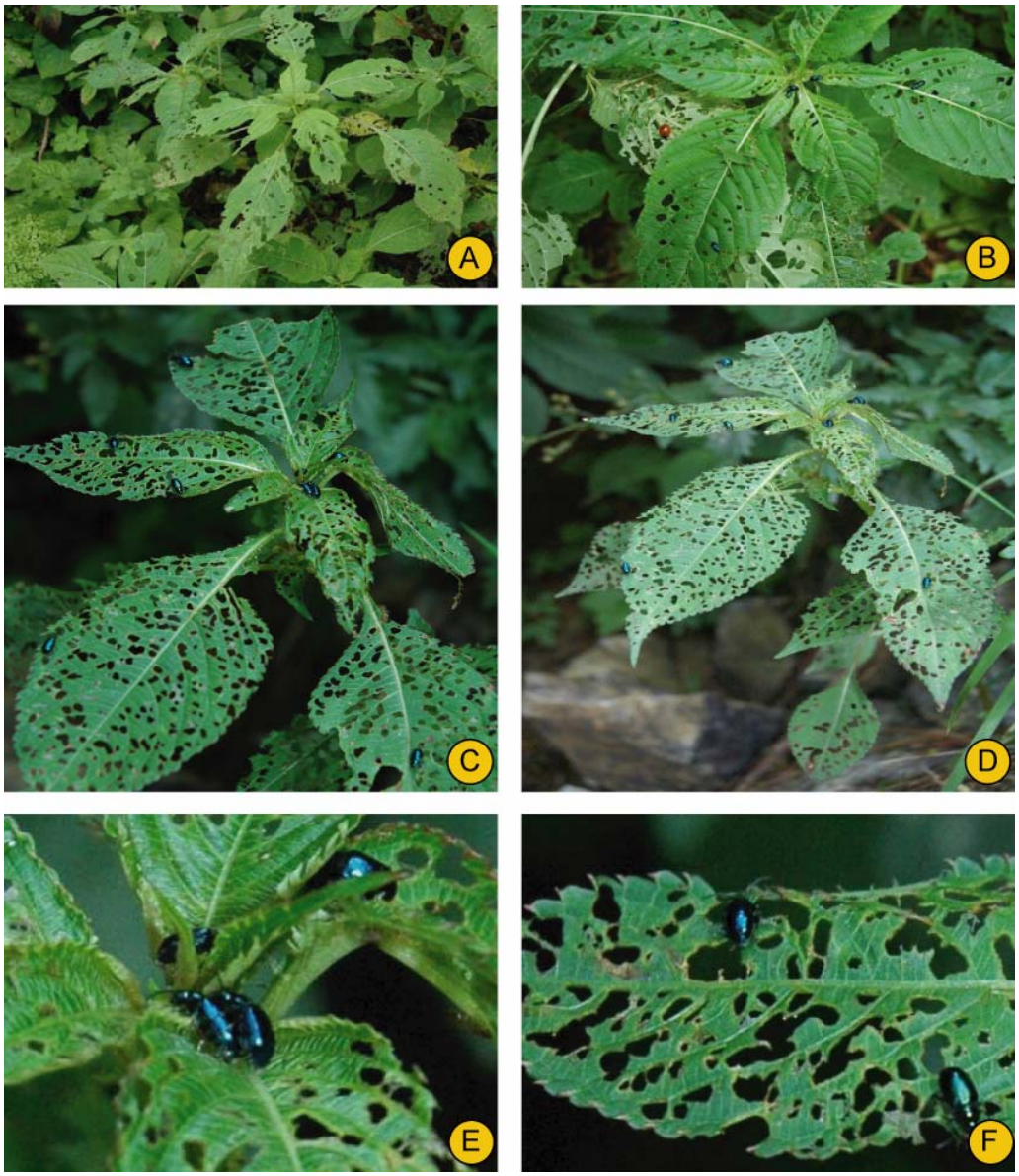

Fig. 5. A-F: Photographs showing insect damage by *Pyrrhalta luteola* at six different times during the 10-years sampling period.

Tanner *et al.,* (2008) suspected it as if it is due to a rust strain on a different biotype of Impatiens. Ahmad (1956 a & b) reported *Puccina argentata* from leaves of *I. brachycentra* from Swat, Changla gali & Murree hills. Recently, Sultan *et al.,* (2006) reported same rust species from *Impatiens brachycentra* from fairy meadows, northern areas of Pakistan. According to Wilson & Henderson (1966) spermogonia and aecia of *Puccinia argentata* are confined to *Adoxa moschatellina* while uredia and telia are confined to *Impatiens* spp. It is suggested that some biotype specificity testing could be done in native range for better understanding of biotypic specificity of this rust. Another interesting fungus with a biocontrol potential was *Phoma exigua* that showed significant symptoms when inoculated to UK biotypes of *I. glandulifera.* However the fungus is a reported pathogen on *Sesamum indicum and Linum utitassimum* from Pakistan (Hussain & Ahmad 1971). The same fungus has also been reported in the present study from Murree hills during surveys in early 2008.

In the present decade-long study it has been observed that a shift in the climate has resulted into an increased population density of the beetle resulting into enhanced herbivory and ultimate mortality of an indigenous herb of Pakistan. These accelerating changes to the Earth's environment are being driven by growth in the human population, by the increasing level of resource consumption by human societies and changes in technology and sociopolitical organization (Steffen *et al*., 2005, Anon., 2007). Global change will likely exacerbate the already significant impacts of pests, diseases and weeds on crop production and natural ecosystems (Anon., 1997). A variety of disturbances like fire, dieback due to insect attack appear to be increasing in some regions which is sooner or later going to lead to an absolutely different ecosystem outlook (Kurz *et al*., 1995).

Steps are needed to be taken to control the insect through integrated management strategies in Pakistan while on the other hand collaboration may be developed with scientist from UK to help them find out potential biocontrol agents from Pakistan for future application in UK against Himalayan balsam.

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References

Ahmed, S. 1956a. Uredinales of West Pakistan. *Biologia.* 2(1): 29-101.

Ahmed, S. 1956b. Fungi of Pakistan. *Biological Society Pakistan Lahore Monograph*, 1: 1-126.

Anonymous. 1997. Report # 1.The Terrestrial Biosphere and Global Change: Implications for natural and managed Ecosystems: A synthesis of GCTE and related research. C

Anonymous. 2004 Crop Protection Compendium, 2004. Edition. CAB International, Wallingford, UK.

Anonymous. 2007. Global change newsletter (Number 69, May 2007), A quarterly published newsletter. Global change and the earth system, A Planet under pressure.

Bown, D. 1995. *Encyclopaedia of Herbs and their Uses.* Dorling Kindersley, London.

Dickore, W.B and N. Marcus. 2000. Flora of Nanga Parbat (NW Himalaya, Pakistan): An Annotated inventory of vascular plants with remarks on vegetation dynamics: Botanischer Garten und Botanisches Museum, Berlin-Dahlem

Hulme, P.E. and E.T. Bremner. 2005. Assessing the impact of *Impatiens glandulifera* on riparian habitats: partitioning diversity components following species removal. *Journal of Applied Ecology*, **43:** 43-50.

Kunkel, G. 1984. *Plants for Human Consumption.* Koeltz Scientific Books.

Kurz, W.A., M.J. Apps, S.J. Beukema and T. Lekstrum. 1995. 20th Century carbon budget of Canadian forests. *Tellus*., 47B: 170-177.

Steffen, W., A. Sanderson, J. Jäger, P.D. Tyson, B. Moore III, P.A. Matson, K. Richardson, F. Oldfield, H.J. Schellnhuber, B.L. Turner II and R.J. Wasson. 2005. Global change and the earth system, A Planet under pressure. Springer Verlag, *Heidelberg*, Germany, 336 pp.

Sultan, M.A., I. Haq, A.N. Khalid and H. Mukhtar. 2006. A contribution to Uredinales of Northern areas of Pakistan. Mycopath *Mycopath*, 4(2): 9-11.

Tanner, R., C. Ellison, R. Shaw, H. Evans and A. Gange. 2008. Losing patience with *Impatiens*: Are Natural enemies the solution? *Out looks on Pest Management.* April 2008.

Wilson, M and D.M. Henderson. 1966. British Rust Fungi. University Printing House, Cambridge,U.K.

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