

# Immediate hypersensitivity to *Parthenium hysterophorus*. II. Clinical studies on the prevalence of *parthenium* rhinitis

P. SRIRAMARAO, S. NAGPAL, B. S. SUBBA RAO\*, OM PRAKASH\*  
and P. V. SUBBA RAO†

Laboratory of Immunology and Allergic Diseases, Department of Biochemistry, Indian Institute of Science and

\*Division of Medicine, St Martha's Hospital, Bangalore, India

## Summary

The airborne pollen of the South American weed, *Parthenium hysterophorus* (American feverfew), accidentally introduced into India was found to be responsible for severe allergic rhinitis. A random clinical survey conducted on 2035 residents of Bangalore city with the aid of questionnaires and skin tests revealed that 7.1% of the study population was suffering from allergic rhinitis due to exposure to *Parthenium* pollen. Skin-prick tests performed on 1294 clinic patients suffering from nasobronchial allergy during the past 4 years have also shown that 42.5% were sensitive to *Parthenium* pollen. IgE and IgG antibodies specific for *Parthenium* pollen allergens were demonstrable in the sera of *Parthenium*-sensitive rhinitis patients. The specificity of these antibodies to *Parthenium* allergens was established by ELISA. A 7- to 11-fold higher stimulation was observed when lymphocytes from two *Parthenium*-sensitive rhinitis patients were treated *in vitro* with *Parthenium* pollen extract. To our knowledge, nowhere in the world has such a high incidence of allergic rhinitis due to a single pollen ever been reported.

*Clinical and Experimental Allergy*, Vol. 21, pp. 55–62. Submitted 23 November 1989; revised 22 June 1990; accepted 16 July 1990.

## Introduction

The Compositae weed, *Parthenium hysterophorus* (American feverfew) which is related to *Ambrosia* (ragweed) is a native of Argentina, Mexico, West Indies and Southern parts of the U.S.A. It is presumed to have been accidentally introduced into India around 1956, along with the imported wheat grains, and more recently to Australia [1]. After its initial appearance in Poona city, the weed soon became adapted to the Indian soil and climate and within two decades it had spread extensively to many parts of India. There is no vacant land in and around the city of Bangalore (South India) which is free from *Parthenium* weed. Like ragweed of the American midwest, *Parthenium* was found to cause allergic contact dermatitis affecting the exposed skin surface of adult subjects [2–4]. A daily survey of the atmospheric pollen in Bangalore conducted during January–December 1979 revealed that *Parthenium* pollen was windborne in highly significant

amounts either as individual pollen grains or in the form of clumps (consisting of 2–80 grains) [5] and was responsible for allergic rhinitis [6]. Although the clinical and immunological studies established that *Parthenium* pollen is a potent atopic allergen, the percentage of the population sensitized to this pollen is not known. The present study was therefore undertaken to determine the prevalence of *Parthenium* rhinitis in a random population from Bangalore as well as in patients suffering from nasobronchial allergy, by skin-prick test and quantification of *Parthenium* pollen-specific IgE antibodies by avidin–biotin/microELISA.

## Materials and methods

### Materials

Tween-20, heparin and bovine serum albumin (BSA) (Sigma Chemical Co., St Louis, U.S.A.), *o*-phenylenediamine (Aldrich Chemical Co., Milwaukee, U.S.A.), hydrogen peroxide (3%, v/v) (Glaxo Laboratories India Ltd, Bombay), CNBr-activated Sepharose 4B, Ficoll–Paque (Pharmacia Fine Chemicals, Uppsala, Sweden), biotin-*N*-hydroxysuccinimide ester (Vega Biochemicals, Tus-

Correspondence: Professor P. V. Subba Rao, Laboratory of Immunology and Allergic Diseases, Department of Biochemistry, Indian Institute of Science, Bangalore 560012, India.

con, U.S.A.), horseradish peroxidase-avidin conjugate (Vector Laboratories, Burlingame, U.S.A.), RPMI-1640 medium with L-glutamine, fetal calf serum (Gibco Laboratories, Grand Island, U.S.A.), [ $^3\text{H}$ ]thymidine (Bhabha Atomic Research Centre, Bombay, India) and polystyrene microtitre plates (96-well flat-bottom) with lids (Costar, Cambridge, U.S.A.), were obtained from the manufacturers. Mite (*Dermatophagoides farinae*) extract (1:10 w/v) was obtained from Walter Reed Army Medical Center, Allergy Extract Laboratory, Washington, DC., while skin-prick test extracts of *Amaranthus*, *Carica papaya*, *Ricinus communis*, *Chenopodium*, *Aspergillus*, *Alternaria*, *Cladosporium* and grass pollen (1:10, w/v) were purchased from Curewel, Faridabad, India. All other chemicals were of analytical grade and available commercially.

#### Collection of *Parthenium* pollen

The stalks of freshly cut and washed inflorescences of *Parthenium* were immersed in water and kept in a dust-free room until the anthers dehisced. The shed pollen was collected after sieving through a 250  $\mu\text{m}$  mesh, defatted by washing repeatedly with chilled peroxide-free ether and dried under a vacuum. The dehydrated pollen, with 98% purity (microscopic examination), was stored in a dessicator at  $-20^\circ\text{C}$  until further use.

#### Preparation of *Parthenium* allergen extract for skin test

Defatted *Parthenium* pollen was extracted with PBS, pH 7.4 for 20 hr at  $4^\circ\text{C}$  (1:10, w/v). The extract was then filtered, centrifuged at  $20\,000 \times g$  for 20 min and diluted with equal volumes of glycerol after passing through a sterile millipore filter (0.45  $\mu\text{m}$ ). The resultant allergen extract (1:20, w/v) was stored at  $4^\circ\text{C}$  and used for skin tests.

#### Skin test procedure

Skin-prick tests were performed with allergen extracts on the volar surface of the forearm of patients as well as control subjects according to the procedure described by Pepys *et al.* [7]. A 50% glycerine solution in PBS (pH 7.4) and histamine hydrochloride (1 mg/ml) dissolved in PBS-glycerol (1:1 v/v) served as negative and positive controls, respectively. The size of the weal after 15 min was determined by measuring the diameter in two perpendicular directions and then halving the sum. The reaction was designated as positive if the net weal diameter was greater than 3 mm over the negative control.

#### Study design

The purpose of the present study was to determine the prevalence of sensitivity to *Parthenium* pollen in a large

and unselected population as well as in symptomatic subjects reporting at the clinic with rhinitis and/or asthma. The patients with rhinitis were selected based on history of recurrent rhinorrhea, stuffy nose and sneezing, occurring either perennially or seasonally. Asthma patients were selected on recurrent wheeze and dyspnoea occurring perennially or seasonally and responding to bronchodilators. A survey was planned accordingly and skin-prick tests were performed on normal controls, subjects with rhinitis and/or bronchial asthma.

#### Patients

During the 'open days' at the Indian Institute of Science in connection with the Platinum Jubilee year (3–5 March 1985) the general public visited various departments. This opportunity was utilized to conduct a random survey of the urban population to determine the incidence of nasobronchial allergy as well as sensitivity to *Parthenium* pollen and house dust mite, two dominant airborne allergens in Bangalore. A booth was set up in the department where 2035 out of over 10 000 visitors of either sex in the age group of 3–65 yr (1308 males and 727 females), randomly participated in the survey. Persons in the survey included schoolchildren, college students, housewives, persons employed in various jobs and retired personnel. The study population was from different residential areas of Bangalore and represented different economic groups. After obtaining a brief clinical history on a printed proforma, they were subjected to skin-prick tests to determine their sensitivity to *Parthenium* pollen and house dust mite. The skin reactions were recorded at the exit point, which the subjects reached in about 20 min.

In addition to the subjects who participated in the random survey, 1294 patients of either sex in the age group of 15–65 yr suffering from allergic rhinitis or bronchial asthma who visited the allergy clinic associated with our Laboratory, were also included in the study. Healthy individuals of the same age group with no history of atopy (rhinitis, asthma or atopic dermatitis) served as normal controls. Sera collected from allergic patients and normal volunteers were stored at  $-70^\circ\text{C}$  until use.

#### Quantification of *Parthenium* pollen-specific IgE and IgG antibodies

*Parthenium* pollen-specific serum IgE and IgG antibodies were measured by a previously described avidin-biotin/microELISA (AB-microELISA) procedure [8] with a minor modification. Heat-inactivated goat serum (2%) was used instead of bovine serum albumin (1%) as a blocking agent to prevent non-specific binding. The mean binding of *Parthenium*-specific IgE and IgG is expressed

as ELISA units/ml of undiluted serum where one ELISA unit is defined as an absorbance value of 1.0 at 492 nm. In the ELISA, serum from the patient was diluted appropriately and pre-incubated for 1 hr at 37°C with increasing concentrations of *Parthenium* pollen extracts (0.0001–10 µg/ml) before adding the mixture to antigen-coated wells. Subsequent steps of the assay were the same as those described for AB-microELISA procedure.

#### Lymphocyte transformation test

Heparinized blood was obtained from three normal subjects and two rhinitis patients with positive skin-prick reactions to *Parthenium* pollen and elevated levels of *Parthenium*-specific serum IgE. Peripheral blood mononuclear cells (PBMC) were separated from venous blood (diluted with equal volume of PBS) by Ficoll-Paque density gradient centrifugation. The cells were washed three times with PBS and resuspended in RPMI-1640 tissue culture medium supplemented with HEPES (25 mM), L-glutamine (1%), penicillin (100 U/ml) streptomycin (100 µg/ml) and heat-inactivated foetal calf serum (10%).

Cultures in duplicate containing 200 µl of  $5 \times 10^6$  PBMC were added to sterile round-bottom microtitre wells and incubated with *Parthenium* pollen extract (0–128 µg/ml) for 6 days in a humidified atmosphere of 5% CO<sub>2</sub> at 37°C. Cultures with PBMC from normal patients served as controls. The cells were harvested onto glass fibre discs using a semi-automated harvester (PHD cell harvester, Cambridge, U.S.A.) 16 hr after the addition of 0.5 µCi [<sup>3</sup>H]thymidine (specific activity 6.6 Ci/mmol). The radioactivity was measured with the aid of a toluene-based scintillation fluid. The response of the cultured cells expressed as stimulation index (SI) was obtained by dividing the radioactivity of the stimulated cell cultures with that of the non-stimulated cell cultures.

#### Statistical analysis

The significance of difference in distribution and linear correlation coefficient was calculated as described previously [9].

## Results

#### Random clinical survey

Table 1 shows the incidence of rhinitis or asthma in the study group. Thirty-six per cent of the randomly selected subjects were females. Among the survey group, 2.95% gave clinical history suggestive of bronchial asthma while 19.2% complained of nasal problems, mostly rhinitis. The percentage of subjects suffering from the latter symptoms

**Table 1.** Random survey on the incidence of rhinitis or asthma in the Bangalore population

| Sex    | n    | Rhinitis* (%) | Asthma† (%) |
|--------|------|---------------|-------------|
| Male   | 1308 | 19.8          | 2.9         |
| Female | 727  | 18.2          | 3.0         |
| Both   | 2035 | 19.2          | 2.95        |

\* Sneezing, watery eyes, running and/or blocked nose in the absence of cold.

† Chest tightness and recurrent wheezing.

**Table 2.** Sensitivity of a random population from Bangalore (n = 2035) to *Parthenium* pollen and house dust mite

| Study group  | Percentage of individuals with positive skin reaction to: |                 |      |
|--------------|-----------------------------------------------------------|-----------------|------|
|              | <i>Parthenium</i> pollen                                  | House dust mite | Both |
| Total        | 9.6                                                       | 4.3             | 1.6  |
| Rhinitis     | 7.1                                                       | 2.6             | 1.3  |
| Asthma       | 0.4                                                       | 0.8             | 0.1  |
| Asymptomatic | 1.8                                                       | 0.8             | 0.2  |

**Table 3.** Sensitivity of patients with nasobronchial allergy to *Parthenium* pollen and house dust mite

| Study group | n   | Percentage of patients suffering from nasobronchial allergy with positive skin to: |                 |      |
|-------------|-----|------------------------------------------------------------------------------------|-----------------|------|
|             |     | <i>Parthenium</i> pollen                                                           | House dust mite | Both |
| Rhinitis    | 391 | 26.1                                                                               | 9.5             | 4.9  |
| Asthma      | 60  | 13.3                                                                               | 28.3            | 3.3  |

**Table 4.** Incidence of *Parthenium* sensitivity among patients with nasobronchial allergy

| Year | n    | Patients sensitive to <i>Parthenium</i> pollen (%)* |            |            |
|------|------|-----------------------------------------------------|------------|------------|
|      |      | Total                                               | Male       | Female     |
| 1985 | 315  | 35.7                                                | 35.2       | 37.0       |
| 1986 | 259  | 43.8                                                | 50.0       | 31.9       |
| 1987 | 362  | 45.7                                                | 49.7       | 40.3       |
| 1988 | 358  | 45.6                                                | 49.0       | 37.5       |
| n =  | 1294 | 42.5 ± 3.9                                          | 46.0 ± 6.2 | 36.7 ± 3.0 |

\* The figures represent the percentage of patients sensitive to *Parthenium* pollen alone or in association with other allergens as determined by positive skin-prick reaction to *Parthenium* pollen (1:20) and other allergen extracts (1:10 w/v).

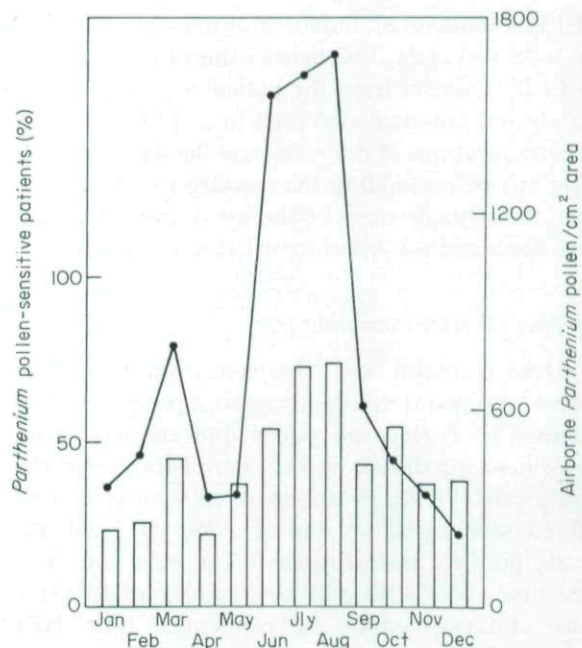
**Table 5.** Results of skin-prick test reaction of rhinitis patients (n = 810) to *Parthenium* and other common airborne allergens

| Allergen(s)                                                      | Percentage of patients showing positive reaction |
|------------------------------------------------------------------|--------------------------------------------------|
| <i>Parthenium</i> pollen                                         | 37.9                                             |
| <i>Parthenium</i> pollen + house dust mite                       | 12.5                                             |
| <i>Parthenium</i> pollen + allergens other than house dust mite* | 2.7                                              |
| House dust mite                                                  | 11.9                                             |
| Allergens other than <i>Parthenium</i> and house dust mite       | 2.3                                              |

\* Pollen of *Amarantus*, *Carica papaya*, *Chenopodium* and grass; castor bean, *Aspergillus*, *Alternaria* and *Cladosporium* (1:10, w/v). A weal greater than 3 mm in diameter above the negative saline control was taken as a positive reaction.

(males 19.8% and females 18.2%) was far higher than the percentage of individuals who complained of asthma (males 2.9% and females 3.0%).

Skin-prick tests were performed on the study group to determine their sensitivity to *Parthenium* pollen and house dust mite, two dominant aero-allergens prevalent in Bangalore. From Table 2 it is apparent that 9.6% of a total population of 2035 who participated in the survey were sensitive to *Parthenium* pollen alone while 4.3% were sensitive to house dust mite and an additional 1.6% to both *Parthenium* and house dust mite. Furthermore,

**Fig. 1.** Seasonal variation in the concentration of airborne *Parthenium* pollen (●—●) and the incidence of *Parthenium* rhinitis (□). The aerobiological data were taken from an earlier study [5]. Sensitivity to *Parthenium* pollen was determined by skin-prick test. For details see Materials and methods.

among the total study group. 7.1% and 2.6% of the subjects suffering from rhinitis were sensitive to *Parthenium* pollen and house dust mite respectively, and an additional 1.3% were sensitive to both allergens. While only 0.4% of the study group suffering from bronchial asthma were sensitive to *Parthenium* pollen, 0.8% and 0.1% of the patients suffering from asthma were sensitive to house dust mite or both the allergens respectively. In addition, 1.8% and 0.8% of the asymptomatic subjects also elicited positive skin reactions to *Parthenium* pollen and house dust mite, respectively.

Among the rhinitis patients (n = 391), 26.1% were sensitive to *Parthenium* pollen alone, while 9.5% and 4.9% were sensitive to house dust mite or both the allergens, respectively (Table 3). However, 13.3% of the asthmatics (n = 60) gave a positive skin reaction to *Parthenium* pollen, while 28.3% were sensitive to house dust mite and 3.3% to both the allergens.

#### Clinical studies on patients with nasobronchial allergy

Skin tests were also performed on 1294 subjects reported at our clinic with nasobronchial allergy (810 rhinitis patients and 484 asthmatics) who visited the allergy clinic associated with our Laboratory between 1985 and 1988 to

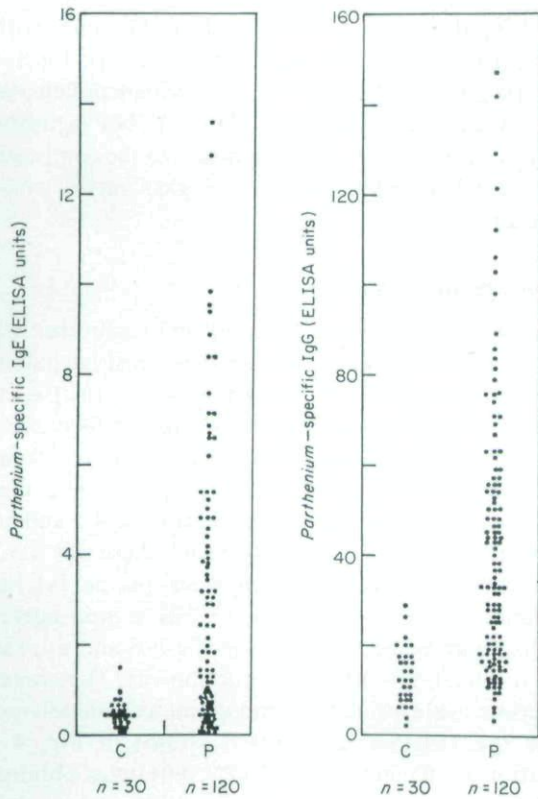


Fig. 2. Levels of *Parthenium* pollen-specific IgE and IgG antibodies in the sera of *Parthenium*-sensitive rhinitis patients by AB-microELISA. P, patients, C, control subjects. For details see Materials and methods.

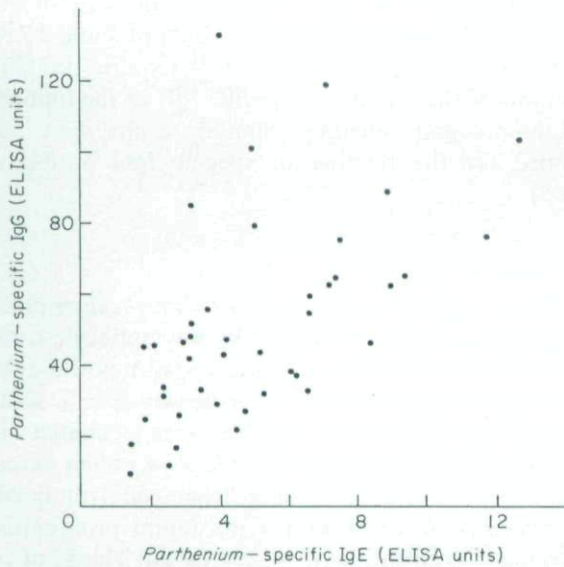


Fig. 3. Correlation between *Parthenium*-specific IgE and IgG in the sera of *Parthenium*-sensitive rhinitis patients ( $r=0.55$ ;  $P<0.001$ ).

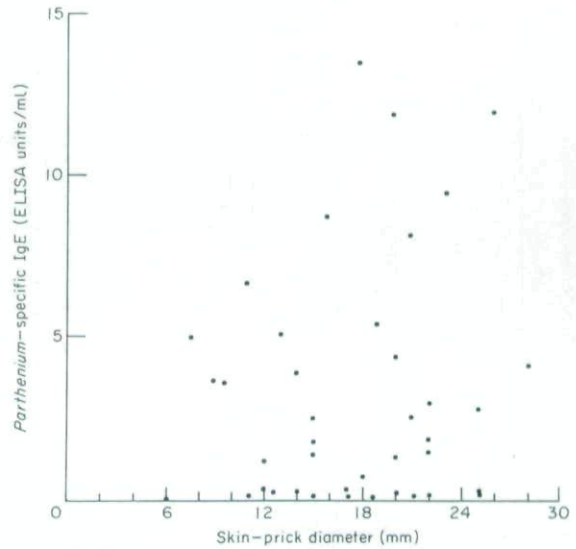


Fig. 4. Correlation between skin-prick test and *Parthenium*-specific IgE in the sera of *Parthenium*-sensitive rhinitis patients ( $r=0.67$ ;  $P<0.01$ ).

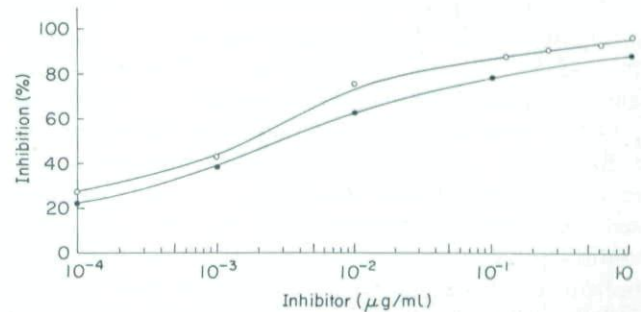


Fig. 5. ELISA inhibition curves for *Parthenium*-specific IgE antibodies. For experimental details see Materials and methods.

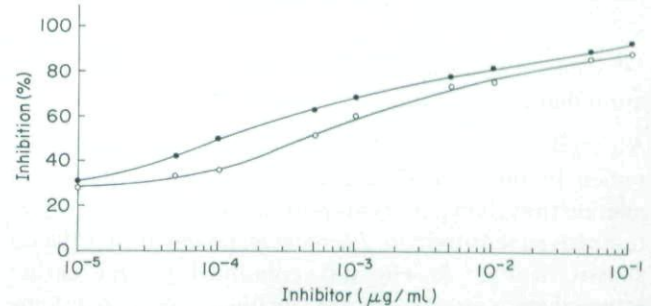


Fig. 6. ELISA inhibition curves for *Parthenium*-specific IgG antibodies. For experimental details see Materials and methods.

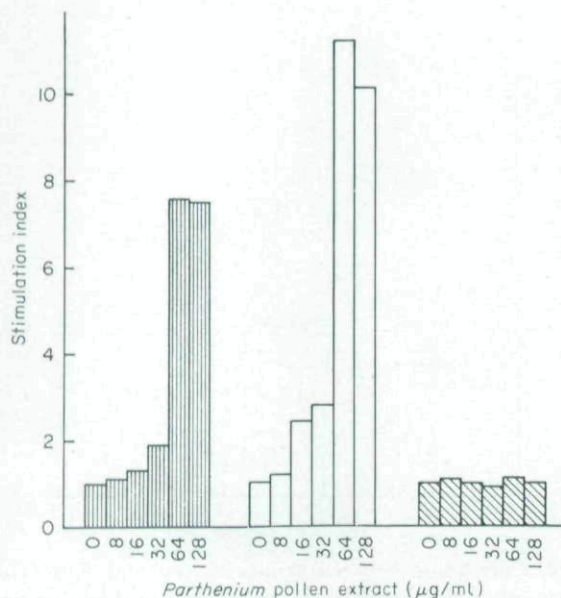


Fig. 7. *Parthenium* pollen allergen-induced proliferation of lymphocytes from *Parthenium*-sensitive rhinitis patients. (■) patient 1; (□) patient 2; (▨) control subject.

assess their sensitivity to *Parthenium* pollen. The results are summarized in Table 4. From the data, it is apparent that 42.5% of the total patients with nasobronchial allergy elicited positive skin reactions to *Parthenium* pollen either exclusively or in addition to other allergens.

Skin-prick tests performed on 810 rhinitis patients revealed that 37.9% of the total subjects were strikingly sensitive exclusively to *Parthenium* pollen (Table 5). An additional 12.5% were sensitive not only to *Parthenium* pollen but also to house dust mite and 2.7% to other airborne allergens. In comparison, however, only 11.9% of the total rhinitis patients elicited positive skin reactions to house dust mite alone and 2.3% to allergens other than *Parthenium* pollen and house dust mite present in significant amounts in the Bangalore atmosphere (*Amaranthus*, *C. papaya*, *Chenopodium*, grass pollen, *R. communis*, *Aspergillus*, *Alternaria* and *Cladosporium*).

#### Seasonal variation in the concentration of airborne *Parthenium* pollen and incidence of allergic rhinitis

A correlation between the concentration of *Parthenium* pollen in the Bangalore atmosphere and incidence of allergic rhinitis in patients reported at our clinic with skin-test proven sensitivity to *Parthenium* pollen during 1987 is shown in Fig. 1. The data obtained in our earlier atmospheric survey for the incidence of *Parthenium* pollen [5] were used for comparison. The incidence of allergic rhinitis attributable to *Parthenium* pollen was also

high during the monsoon months (June–October) with a maximum in July and August, and 71.6% of the total rhinitis patients were sensitive to *Parthenium* pollen alone or in association with other allergens. No significant amounts of pollen from other members of the compositae family were detected in the aerobiological survey carried out earlier [5].

#### Allergen-specific antibodies

*Parthenium* pollen-specific IgE and IgG antibodies were demonstrable in the sera of *Parthenium*-sensitive patients by AB-microELISA (Fig. 2). While 61% of the patients with positive skin reactions to *Parthenium* pollen extract had varying amounts of allergen-specific IgE, 65.8% had elevated levels of specific IgG antibodies. The mean binding of allergen-specific IgE and IgG was 4.5 and 56.0 ELISA units/ml, respectively. Although there was significant correlation between *Parthenium*-specific IgE and IgG values ( $r=0.55$ ,  $P<0.001$ ) (Fig. 3), a poor correlation was observed between the specific IgE and total IgE values ( $r=0.24$ ;  $P<0.1$ ) (data not shown). The correlation between skin-prick test (mm diameter) and allergen-specific IgE (ELISA units/ml) is shown in Fig. 4. A correlation coefficient of 0.667 ( $P<0.01$ ) was obtained. Specificity of the IgE antibodies present in the sera of *Parthenium*-sensitive patients was confirmed by ELISA using different concentrations of *Parthenium* pollen extract as inhibitor (0.0001–1 µg/ml). Progressive inhibition in the binding of the specific IgE antibodies in the sera of *Parthenium*-sensitive rhinitis patients was observed with an increase in the inhibitor concentration. Representative curves obtained with the sera of two patients are shown in Fig. 5. An amount of 1.7 and 2.7 ng/ml of *Parthenium* pollen extract was required for 50% inhibition of the binding of specific IgE to the immobilized homologous allergen. Similar results were also obtained for the binding of specific IgG antibodies (Fig. 6).

#### Lymphocyte proliferation

The sensitivity of rhinitis patients to *Parthenium* pollen allergens was confirmed further by a lymphocyte transformation test. PBMC of two patients (with positive skin reactions and elevated levels of *Parthenium*-specific serum IgE) and from three control subjects were incubated with increasing concentrations of *Parthenium* pollen extract (0–128 µg/ml) (Fig. 7). A dose-dependent lymphocyte response was obtained with a maximum proliferation between a concentration of 64–128 µg/ml. The SI of cell cultures of normal subjects incubated with increasing concentrations of the allergen extract, however, remained equal or less than 1 (average for three individuals).

## Discussion

Pollen of *Parthenium* is windborne either singly or in clumps and in areas heavily infested with the weed (e.g. Bangalore) 48% of the pollen in the atmosphere during the months of June–September is derived from *Parthenium* [5]. A steady increase in the incidence of allergic rhinitis was noticed in Bangalore during the past decade which corresponded with the increased spread of the weed.

A clinical survey conducted on 2035 residents of Bangalore city revealed that among the study subjects suffering from rhinitis, 7.1% were sensitive to *Parthenium* pollen alone and an additional 1.3% elicited positive skin reactions to *Parthenium* and house dust mite, while 2.6% were sensitive only to house dust mite (Table 3). Studies also performed on 1294 subjects suffering from nasobronchial allergy who visited our clinic between 1985 and 1988 revealed that out of the 810 patients suffering from rhinitis, 37.9% were sensitive exclusively to *Parthenium* pollen, while an additional 12.5% with sensitivity to house dust mite and 2.7% to other inhalant allergens also elicited strong skin-prick reactions to *Parthenium* pollen (Table 5).

Measurement of *Parthenium*-specific IgE by the AB-microELISA revealed that only 61% of the skin-test positive *Parthenium*-sensitive patients had significant levels of allergen-specific IgE in their sera. Although a high correlation (greater than 80%) between RAST, ELISA and skin tests has been reported [13–15], several investigators recorded only 50–66% agreement for *Parthenium*, birch, ragweed, grass pollen and mould allergens [6,16–18]. A positive skin test without detectable levels of allergen-specific IgE was the discordant result most frequently encountered in these studies. The discordance of results obtained with *Parthenium* pollen allergens does not seem to be due to the presence of irritant substances as only 1.8% of the asymptomatics elicited positive skin reactions to *Parthenium* pollen (Table 2). Furthermore, the presence of blocking antibodies (IgG) at levels that might interfere with the measurement of allergen-specific IgE by ELISA is unlikely as none of the patients included in the present study were undergoing hyposensitization for *Parthenium*. As high titres of allergen-specific IgG antibodies are known to compete with IgE for binding to the solid-phase allergen, it is possible that elevated levels of *Parthenium*-specific IgG found in the sera of 68% of the patients could be one of the reasons for the inability to detect *Parthenium*-specific IgE antibodies in the sera of patients with positive skin reaction to extracts of *Parthenium* pollen. This may not be true, however, because elevated levels of both *Parthenium*-specific IgE and IgG, with a significant correlation between them ( $r=0.55$ ;

$P<0.001$ ), were demonstrable in the sera of a number of patients (Fig. 3). The other possibility for the negative ELISA results could be the presence of allergen-specific anaphylactic antibodies of IgG<sub>4</sub> subclass which are known to induce positive skin reactions [19,20]. Lymphocytes from *Parthenium*-sensitive patients were found to be stimulated *in vitro* by *Parthenium* allergens (Fig. 7). Similar lymphoproliferative responses to purified allergens from other sources have been reported [21–23].

In a recent study on the allergenic reactivity of *P. hysterophorus* pollen in the United States Gulf Coast area, Wedner *et al.* [24] concluded that *Parthenium* represents a unique allergen whose importance has largely been overlooked. The present studies established that *Parthenium* is one of the most potent allergens responsible for the highest incidence of allergic rhinitis due to a single pollen. However, it does not seem to be significantly responsible for bronchial asthma. Based on clinical history and skin tests performed on individuals living in areas heavily infested with *Parthenium* weed for the past 5 years, the rhinitis patients could be categorized into four groups, namely (1) those who were not sensitive to common inhalant allergens (vasomotor rhinitis), (2) those sensitive to house dust mite and other allergens but not to *Parthenium* pollen, (3) those sensitive to *Parthenium* and one or more other inhalant allergens, and (4) those who were exclusively sensitive to *Parthenium* pollen. The latter group constitutes the major group of individuals allergic to *Parthenium*.

Thus *Parthenium*, which was hitherto an unrecognized world-wide allergen, is now gaining importance as a potent allergen in disturbed sites. Furthermore, there are indications that with the widespread growth of *Parthenium* in India, large sections of the population are getting increasingly sensitized. So far, attempts to control the weed have been dismally unsuccessful. Disturbing reports of cases of *Parthenium* allergy from U.S.A. [24] and Australia [J. A. Stewart, personal communication] are now available. The Indian experience would indicate that there should be a global interest in intense ecological surveillance so that fortuitous entry of the weed to other countries can be effectively prevented.

## Acknowledgments

This paper is dedicated to the memory of J. N. Tata, the Founder of the Indian Institute of Science. Financial support was received through grants from the Karnataka State Council for Science and Technology and the Department of Environment, Government of India. We thank R. Uthayashankar, H. G. Sumana and K. N. Vijayalakshmi for their assistance in conducting the random clinical survey and A. V. Narayan and R. N. Narahari for preparing the manuscript.

## References

- 1 Towers GHN, Mitchel JC, Rodriguez E, Bennett FD, Subba Rao PV. Biology and chemistry of *Parthenium hysterophorus* L., a problem weed in India. *J Sci Ind Res* 1977; 36:672-84.
- 2 Prakash KM, Mangala A, Subba Rao BS, Subba Rao PV. *Parthenium* dermatitis. *Arogya J Health Sci* 1978; 4:28-30.
- 3 Subba Rao PV, Mangala A, Subba Rao BS, Prakash KM. Clinical and immunological studies on persons exposed to *Parthenium hysterophorus* L. *Experientia* 1977; 33:1387-8.
- 4 Lonkar A, Mitchell JC, Calnan CD. *Parthenium* dermatitis. *Trans St Johns Hosp Dermatol Soc* 1974; 60:43-54.
- 5 Mangala A, Vishwanath B, Subba Rao PV. Atmospheric survey of pollen of *Parthenium hysterophorus*. *Ann Allergy* 1981; 47:192-6.
- 6 Rao M, Prakash O, Subba Rao PV. Reagenic allergy to *Parthenium* pollen: evaluation by skin test and RAST. *Clin Allergy* 1985; 15:449-54.
- 7 Pepys J, Roth A, Carol KB. RAST, skin and nasal tests and the history in grass pollen allergy. *Clin Allergy* 1975; 5:431-42.
- 8 Subba Rao PV, McCartney-Franci NL, Metcalfe DD. An avidin-biotin microELISA for rapid measurement of total and allergen-specific human IgE. *J Immunol Methods* 1983; 57:71-85.
- 9 Snedecor GW, Cochran WG. In: Statistical methods. Oxford: IBH Publishing Co., 1968:172-81.
- 10 Hagy GW, Settupane GA. Risk factors for developing asthma and rhinitis. A 7 year follow-up study of college students. *J Allergy Clin Immunol* 1976; 58:330-6.
- 11 Barbee RA, Lebowitz MD, Thompson HC, Burrows B. Immediate skin test reactivity in a general population sample. *Ann Int Med* 1976; 84:129-35.
- 12 Lindblad JH, Farr RS. The incidence of positive intradermal reactions and the demonstration of skin sensitizing antibody to extracts of ragweed and dust in humans without history of rhinitis or asthma. *J Allergy* 1961; 32:392-8.
- 13 Ali M, Ramanarayan MP. Correlation of a microELISA assay with the skin test and the RAST assay in inhalent allergy. *Ann Allergy* 1984; 53:143-50.
- 14 Negrini AC, D'Aste N, Scarsi PG, Troise C, Voltolini S. La diagnostica immuno-enzymatica nella sensibilizzazione, a. Parietaria: raffronto con tests cutanei e RAST. *Folia Allergol Immunol Clin* 1983; 30:211-16.
- 15 Ali M, Nalebuff DI, Ramanarayanan R, Fayemi AO, Mesa-Teyada R. Assay of IgE antibodies against June and Timothy grasses by an immuno peroxidase technique. *Clin Allergy* 1980; 10:203-10.
- 16 Akiyama K, Yui Y, Shida T, Miyamoto T. Relationship between the results of skin, conjunctival and bronchial tests and RAST with *Candida albicans* in patients with asthma. *Clin Allergy* 1981; 11:343-52.
- 17 Perera MG, Bernstein IL, Michel JG. Predictability of the radio-allergosorbent test (RAST) in ragweed pollenosis. *Ann Rev Respir Dis* 1975; 111:605-10.
- 18 Berg T, Bennich H, Johansson SGO. *In vitro* diagnosis of atopic allergy. I. A comparison between provocation tests and the radioallergosorbent test. *Int Arch Allergy Appl Immunol* 1971; 40:770-8.
- 19 Vijay HM, Perelmutter L. Inhibition of reagin-mediated PCA reactions in monkeys and histamine release from human leucocytes by human IgG<sub>4</sub> subclass. *Int Arch Allergy Appl Immunol* 1977; 53:78-87.
- 20 Stanworth DR, Smith AK. Inhibition of reagin-mediated PCA secretions in baboons by the human IgG<sub>4</sub> subclass. *Clin Allergy* 1973; 3:37-41.
- 21 Buckley RH, Seymour F, Sanal SD, Ownby DR, Becker WG. Lymphocyte responses to purified ragweed allergens *in vitro*. I. Proliferative responses in normal, newborn, agammaglobulinemic and atopic subjects. *J Allergy Clin Immunol* 1977; 59:70-8.
- 22 Gatien JG, Merler E, Cotten HR. Allergy to ragweed antigen E: effect of specific immunotherapy on the reactivity of human T lymphocytes *in vitro*. *Clin Immunol Immunopathol* 1975; 4:32-40.
- 23 Evans R, Reisman RE, Wypych JI, Arbesman CE. An immunologic evaluation of ragweed-sensitive patients by newer techniques. *J Allergy* 1972; 49:285-91.
- 24 Wedner HJ, Zenger VE, Lewis WH. Allergic reactivity of *Parthenium hysterophorus* (Santa Maria Feverfew) pollen: an unrecognized allergen. *Int Arch Allergy Appl Immunol* 1987; 84:116-22.

This document is a scanned copy of a printed document. No warranty is given about the accuracy of the copy. Users should refer to the original published version of the material.