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Impacts of *Parthenium hysterophorous* on plant diversity at head Qadirabad, Punjab, Pakistan

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ABSTRACT

Introduction: *Parthenium hysterophorus* L. is a rapid maturing and growing exotic species, this weed is native to the subtropical areas in North and South America and now a burdensome weed in Pakistan. Now it is an invasive species of neotropical origin and *P. hysterophorus* is distributing rapidly in Khyber Pakhtunkhwa and Punjab provinces, Pakistan. The main objectives of the research was to observe the impact of parthenium on summer and spring season plants, wetland diversity and document the distribution of wild plants in a local community.

Materials and Methods: this research was conducted in four selected sites at both upstream (USL, USR) and downstream level (DSL, DSR) of Head Qadirabad, Punjab, Pakistan.

Results: *P. hysterophorus* was recorded to be growing in three out of four documented areas showing 75% prevalence and only 10 weed species exhibited 100% prevalence. Parthenium showed 73% absolute frequency (AF) and 2.65% relative frequency (RF).

Conclusion: This research concludes that *P. hysterophorus* is rapidly colonizing agri-forest wetland at Head Qadirabad of the district Gujranwala, sudden effort are necessary to control its diversity and impact on the natural diversity of wetland.

Key word: Parthenium, Weed, Wetland, Density, Diversity

INTRODUCTION

Wetlands are sites of peatland, marsh, fen or water (temporary or permanent, artificial or natural); lentic or lotic; brackish, fresh or marine water and tide does not exceed 6 meters (Ramsar, 1971). Four to six percent wetlands are present on the surface of world land besides Pakistan has covered 0.78 million hectares, estimated at 9.7% total surface area of the country and noted that coastal wetlands area 26.06 % and 73.935 % of freshwater lakes in Pakistan. In Pakistan, more than 225 wetland areas are present (PWP, 2007). Chaudhry (2010) reported that irregular water accessibility throughout Pakistan is amongst the main reason of loss of wetland and land degradation**.**

P. hysterophorus L. is a rapid maturing and growing exotic species, this weed is native to the subtropical areas in North and South America, but currently widely distributed in other tropical and subtropical countries such as Australia, China, Ethiopia, India, Kenya, Nepal Taiwan and West Indies (Hara *et al*., 1982; Peng *et al*., 1988; McFadyen, 1992; Medhin, 1992; Evans, 1997; Tiwari *et al*., 2005; Shabbir and Bajwa, 2006). The weed has achieved major status in the Australia and India in the start of the 21st century (Navie *et al*., 1996; Evans, 1997; Mahadevappa, 1997; Kaushik *et al*., 2005; Bhowmik *et al*., 2007).

Surveys on various parts of Pakistan revealed that *P. hysterophorus* L. has become more frequently occurring or the 2nd most common weeds in the many of surveyed area. It is noted that *P. hysterophorus* is rapidly distributing and spreading in whole Pakistan (Shabir, 2003). *P. hysterophorus* weed is noted in different areas of Pakistan; and has become a serious threat to grazing lands as well as wastelands habitats especially in rainy districts of Northern Punjab and Central Punjab, and removing the native plants (Javaid and Anjum, 2005; Javaid and Riaz, 2007; Riaz and Javaid, 2007; Javaid *et al.,* 2009; Riaz and Javaid, 2009*).* Presently this weed is

distributed of North western Frontier province, Kashmir and various district of Punjab including Sailkot, Gujranwala, Gujrat, Lahore, Okara, Qasur, Sheikhupura, Jahlum and Rawalpindi, (PPAG, 2008). *P. hysterophorus* has removed and is also removing native plants of Punjab province in the following districts i.e. Gujranwala, Hafizabad, Lahore, Okara, Rawalpindi, Sheikhupura and Sialkot (Javaid and Anjum, 2005; Javaid and Riaz, 2007; Riaz and Javaid; 2007; Javaid *et al*., 2009; Riaz and Javaid, 2009, 2010). The main objectives of the research was to observe the impact of parthenium on summer and spring season plants, wetland diversity and document the distribution of wild plants in a local community.

MATERIALS AND METHODS

The study was performed at a head Qadirabad, Punjab, Pakistan from March 2011 to February 2011. Data were noted from the head Qadirabad about infestation and evaluation of *P. hysterophorus* diversity and was use in this study. A wide range of methods were used during different steps of this study.

Head Qadirabad was situated at the Chenab river. It is present at the distance of 80 kilometer from Lahore district and 45 kilometer from Gujranwala, district. Wetland area of Head Qadirabad having 2816 hectare area and situated upstream left (USL) at 32^{o}20'06 N, 073^{o}41'36 E, 206 M, upstream right (USR) at 32^{o}19'04 N, 073^{o}41'36 E, 210 M, downstream left (DSL) at 32^{o}18'56 N, 073^{o}41'16 E, 199 M, downstream right (DSR) at 32^{o}19'33 N, 073^{o}40'57 E, 200 M (Figure 1). There are two methods are used for the analysis of the biological data.

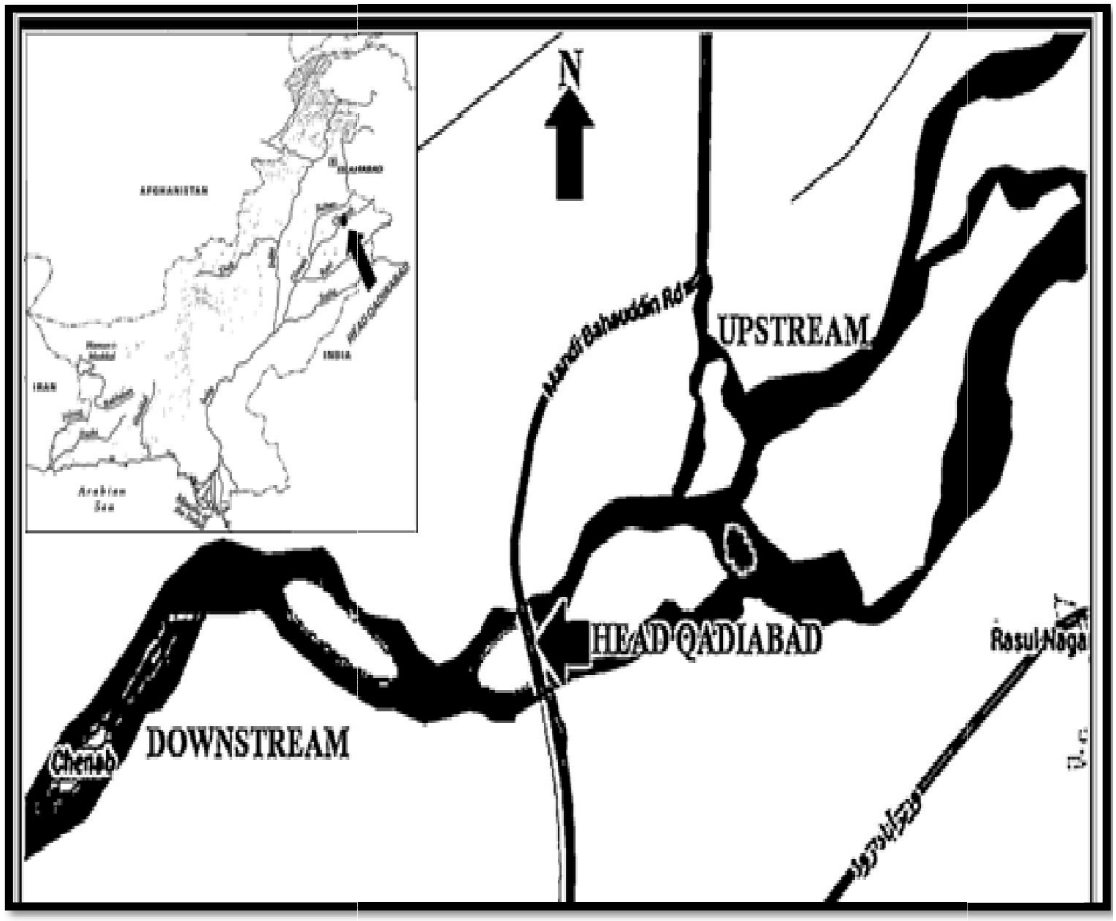

Figure 1: Map of Study area at Head Qadirabad

Numerical Method

Agri-forest wetland was selected in various parts of head Qadirabad, Gujranwala district. The distance between each sampling sites was from 3 to 8 km; each selected site area was 1 hectare; while 10 random quadrates were thrown in each selected site. Prevalence, absolute and relative frequency, and absolute and relative density were calculated by applying the following formulae. The following formulae were used:

$$\text{Absolute frequency (A.F) (\%)} = \frac{\text{Number of quadrates in which a species occur}}{\text{Total No. of quadrates}} \text{ X } 100$$

$$\text{Absolute density (A.D)} = \frac{\text{Total number of individuals of specie in a quadrate}}{\text{Total number of quadrates}}$$

$$\text{Relative density (R.D) (\%)} = \frac{\text{Absolute density for species}}{\text{Total absolute density for all species}} \text{ X } 100$$

$$\text{Prevalence (\%)} = \frac{\text{Number of sites in which a species occur}}{\text{Total number of sites}} \text{ X } 100$$

$$\text{Relative frequency (R.F) (\%)} = \frac{\text{Absolute frequency value for species}}{\text{Total absolute frequency value for all spp.}} \text{ X } 100$$

$$\text{Relative density (R.D) (\%)} = \frac{\text{Absolute density for species}}{\text{Total absolute density for all species}} \text{ X } 100$$

Statistical Method

The diversity and distribution of parthenium was analyzed by statistical software PAST (version 3) (Hammer *et al.,* 2001). Different diversity indices were calculated in order to know the species diversity in different habitat. Calculated diversity indices were as; Simpson's diversity index (Simpson, 1949), Shannon's diversity index (Shannon and Weaver, 1963), richness index (Margalef, 1958.) and evenness index (Pielou, 1966).

RESULTS AND DISSCUSION

Numerical analysis of community consists of the quantitative values. Quantitative values are as; abundance, frequency, density, cover area and basal area of species recorded in a sampling site. These values can be documented as relative or absolute or values.

Total 51 weed species, has 25 families of angiosperms were documented from 4 sampling sites (upstream right and left and downstream right and left) of Head Qadirabad area. *P. hysterophorus* was documented in 3 out of 4 sampling sites and showen 75% prevalence (Table 1). Similarly high prevalence of *P. hysterophorus* has also been documented in many districts of the Punjab as; Lahore, Hafizabad Sialkot, Rawalpindi, Sheikhupura and Okara (Javaid and Anjum, 2005; Javaid and Riaz, 2007; Riaz and Javaid; 2007; Javaid *et al*., 2009; Riaz and Javaid, 2009, 2010).

Parthenium hysterophorus was present in the three studied sites exhibiting 75 % prevalence. Among other 51 species, 10 showed 100 % prevalence, 25 Showed 75 % prevalence and 10 others showed 50% prevalence. The species exhibited comparatively low prevalence included *Amaranthus spinosus* L., *Sisymbrium irio* L., *Euphorbia heliscopia* L., *Alhagi maurorum* Medik, *Brachiaria reptans* L. and *Setaria glauca* Beauv, i.e. 25% (Table 1). The high prevalence of *P. hysterophorus* in the area may be attributed to many factors.

Frequency, the distribution or dispersion of a weed species in a given area ranged from 13 to 88% absolute and 0.43 to 3.43% relative frequencies respectively. Parthenium has 73% absolute and 2.65% relative frequencies. The parthenium frequency was higher than other native weed species; while frequency was only lower than *Digitaria timorensis (Kunth) Balansa, Calotropis procera Br., Tribulus terrestris L., Imperata cylindrica L., Dicanthium annulatum Stapf., Euphorbia prostrata L., Malvestrum tricuspidatum A. Gray, Dactyloctenium aegypticum Beauv., Cynodon dactylon Pers. and Cyperus rotundus L.*. The most frequent and common species in the district were *Tribulus terrestris L., Dactyloctenium aegypticum Beauv., Cynodon dactylon Pers. and Cyperus rotundus L.* with absolute frequency above 85 % (Table 1). Some species of weeds were either absent from the *P. hysterophorus* or their frequency was very

low as compared to *P. hysterophorus*. This phenomenon might be due to the competitive replacement and allelopathic effect by parthenium. These findings supports the results of Pandey *et al.* (1993), Yadav and Chauhan (1998), Sinha and Deo (1999) and Bhowmik, Sarkar and Yaduraju (2007).

Density, the numerical strength of the weeds ranged from 1.13–8.90 absolute density and relative density 0.43–3.43% respectively. Parthenium was found among most densely populated weed species with AD of 6.7 and RD of 2.58%. Density of parthenium was higher than 40 out of 51 weed species. The weed species that showed higher density than parthenium were *Digitaria timorensis (Kunth) Balansa, Calotropis procera Br., Tribulus terrestris L., Imperata cylindrica L., Dicanthium annulatum Stapf., Cannabis sativa L., Euphorbia prostrata L., Malvestrum tricuspidatum A. Gray, Dactyloctenium aegypticum Beauv., Cynodon dactylon Pers. and Cyperus rotundus L.* 1

Similarly, the density of parthenium has also been documented in Lahore, Okara and Hafizabad districts near and in the area of grazing lands (Riaz *et al*., 2007; Javaid and Riaz, 2007; Riaz and Javaid, 2010). Many features are responsible for high distribution and density of *P. hysterophorus* in the area. 1st, weed has high potential of reproduction; it is producing up to 25,000 seeds per plant. 2nd, *P. hysterophorus* has allelopathic property (Navie *et al*., 1996). 3rd, *P. hysterophorus* also has high potential of regeneration (Dagar *et al*., 1976). The plant parts i.e. leaves, root, stem and inflorescence contain different allelochemicals e.g. water soluble phenolics as; anisic, vanicillic, ferulic, caffeic, fumaric acids, coronopilin and parthenin (Picman and Picman, 1984; Vankataiah *et al*., 2003; Belz *et al*., 2007). The absence of enemies of *P. hysterophorus* in Asia is also main cause to rapid spread and dense population of this weed. while, high density of this weed at head Qadirabad could be due to high anthropogenic

impacts i.e. wet habitat, high fertilizer use and low vegetation cover. During the research noted that increasing trend of *P. hysterophorus* invasion might be declined to other weeds species density and distribution.

Table 1: Total Prevalence, Frequency and Density of *P. hysterophorus* and Alien invasive Weeds at Head Qadirabad.

Weed species	Family	P %	AF %	RF %	AD	RD %
Amaranthus spinosus L.	Amaranthaceae	25	13	0.46	1.13	0.43
Amaranthus viridis L.	Amaranthaceae	75	58	2.10	4.98	1.92
Achyranthes aspera L.	Amaranthaceae	75	48	1.73	2.80	1.08
Calotropis procera Br.	Asclepiadaceae	100	75	2.74	7.75	2.99
Eclipta alba Hassk	Asteraceae	50	38	1.37	3.05	1.17
Sonchus asper Hill.	Asteraceae	50	35	1.28	3.65	1.41
Xanhium strumarium L.	Asteraceae	50	38	1.37	2.95	1.14
Conyza ambigua DC.	Asteraceae	50	28	1.00	2.38	0.91
Cirsium arvense (L.) Scop.	Asteraceae	75	55	2.01	5.23	2.01
Ageratum conyzoides L.	Asteraceae	75	65	2.37	5.75	2.21
Parthenium hysterophorus L.	Asteraceae	75	73	2.65	6.70	2.58
Sisymbrium irio L.	Brassicaceae	25	20	0.73	1.85	0.71
Coronopus didymus (L.) Sm.	Brassicaceae	75	65	2.37	6.30	2.43
Chenopodium murale L.	Chenopodicaeae	50	38	1.37	3.23	1.24
Kochia indica Wight	Chenopodicaeae	50	33	1.19	2.30	0.89
Chenopodium album L.	Chenopodicaeae	75	50	1.82	3.18	1.22
Suaeda fruticosa Forsk.	Chenopodicaeae	75	63	2.28	5.58	2.15
Chenopodium ambrosioides L.	Chenopodicaeae	75	65	2.37	5.75	2.21
Convolvulus arvensis L.	Convolvulaceae	75	38	1.37	3.45	1.33
Cyperus rotundus L.	Cyperaceae	100	88	3.19	8.90	3.43
Euphorbia heliscopia L.	Euphorbiaceae	25	25	0.91	2.95	1.14
Euphorbia pilulifera L.	Euphorbiaceae	50	35	1.28	2.63	1.01
Chrozophora tinctoria (L.)A.Juss.	Euphorbiaceae	75	55	2.01	4.75	1.83
Croton sparsiflorus Morong	Euphorbiaceae	75	58	2.10	5.48	2.11
Euphorbia prostrata L.	Euphorbiaceae	100	83	3.01	8.43	3.25
Oxalis corniculata L.	Geraniaceae	75	53	1.92	5.18	1.99
Malva parviflora L.	Malvaceae	75	50	1.82	5.23	2.01
Malvestrum tricuspidatum A. Gray	Malvaceae	100	83	3.01	8.50	3.27
Boerhaavia diffusa L.	Nyctaginaceae	75	60	2.19	5.73	2.21
Alhagi maurorum Medik.	Papillionaceae	25	15	0.55	1.25	0.48
Brachiaria reptans (L.) Gard. & Hubb.	Poaceae	25	15	0.55	1.33	0.51
Setaria glauca Beauv.	Poaceae	25	18	0.64	1.68	0.65

Setaria verticillata Beauv.	Poaceae	50	48	1.73	5.83	2.24
Eleusine indica Gaertn.	Poaceae	75	38	1.37	3.38	1.30
Eragrostis poaeoides Beauv.	Poaceae	75	63	2.28	4.95	1.91
Poa annua L.	Poaceae	75	58	2.10	5.30	2.04
Sorghum helepense Pers.	Poaceae	75	68	2.46	6.20	2.39
Cenchrus pennisetiformis Hochest	Poaceae	75	68	2.46	6.28	2.42
Digitaria timorensis (Kunth) Balansa	Poaceae	100	80	2.92	7.08	2.73
Cynodon dactylon Pers.	Poaceae	100	88	3.19	8.80	3.39
Dactyloctenium aegypticum Beauv.	Poaceae	100	85	3.10	8.60	3.31
Dicanthium annulatum Stapf.	Poaceae	100	83	3.01	8.38	3.23
Imperata cylindrica L.	Poaceae	100	80	2.92	8.28	3.19
Polygonum plebeium R. Br.	Polygonaceae	75	58	2.10	6.23	2.40
Rumex dentatus L	Polygonaceae	75	63	2.28	5.63	2.17
Ranunculus sceleratus L.	Ranunculaceae	75	53	1.92	5.63	2.17
Solanum nigrum L.	Solanaceae	50	40	1.46	3.50	1.35
Datura alba Nees	Solanaceae	75	53	1.92	4.95	1.91
Cannabis sativa L.	Urticaceae	75	70	2.55	8.38	3.23
Lantana camara L.	Verbenaceae	50	38	1.37	4.18	1.61
Tribulus terrestris L.	Zygophyllaceae	100	85	3.10	8.13	3.13

P = Prevalence, AF = Absolute Frequency, RF = Relative Frequency AD = Absolute Density and RD=Relative Density.

The quantitative characteristic as Evenness Index (E) and the species diversity indices; Margalef/ of richness index (R), Shannon-Weiner's diversity index (H) and Simpson's index (D) were calculated according to (Zobel et al. 1987)

The Shannon-Weiner diversity index (H') of USL and USR were 3.83 and 3.55 respectively compared with the index values of downstream left and right area that are 3.43 and 3.05 respectively (Table 2). *P. hysterophorus* diversity in upstream area was higher than other species in downstream area during the study (Figure 2). The low value of diversity index has shown the similarity in homogeneity and the type of species in upstream area due to presence of weeds. A low diversity index showed that high dominance in the use of some species. The Shannon index also showed great species diversity in non-infested areas; while, the index was reduced by 36-51% in weed infested areas by Kohli et al. (2004).

Simpson's index is the proportions of individuals present in an area that belong to species and indicate their importance to diversity. The Simpson diversity index (D) showed that upstream left and right area have higher diversity index, reported as 0.98 and 0.97 respectively compared with the index values of downstream left and right area that are 0.97 and 0.95 respectively (Table 2). Low values of the index correspond to high species diversity. The Simpson diversity index (D) showed that a high level of Simpson's index (close to 1) means a high level of dominance and poor species diversity. A low level of Simpson's index (0) indicates a low level of dominance, therefore high species diversity. Species diversity was analyzed by using formula of Simpson diversity index 1/D ($D = \Sigma [n_i/N]^2$), where n_i is frequency of each species and N is total frequency of all species (Martin et al., 2005). Simpson's index has been noted to be robust for small population sizes even where species number is high (Lande, 1996).

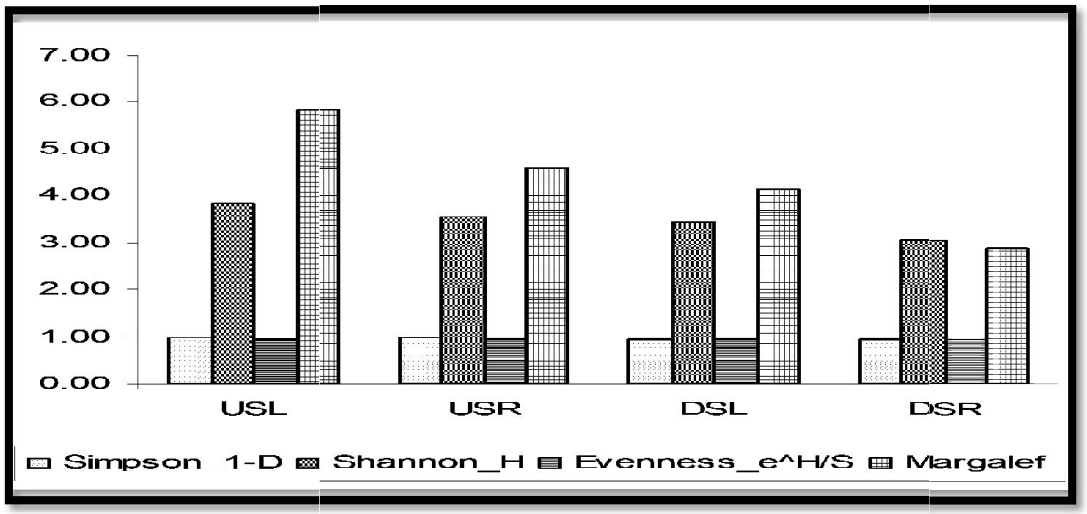

Figure 1: Diversity, Evenness and Richness index of weed Species in upstream and downstream level at Head Qadirabad.

The Evenness index showed that upstream left and right area have index values 0.96 and 0.94 respectively and index values of downstream left and right area that are 0.96 and 0.94 respectively (Table 2). A low evenness means a high dominance in the use of a few species (Begossi, 1996). When all species are equally abundant, an evenness index would be at a maximum (of 1.0) and decrease towards zero as the relative abundances of the species diverge away from evenness (Ludwing and Reynolds, 1988).

The species richness in upstream area was higher than the species richness in downstream area (Figure 2). The species richness index showed that that upstream left and right area have higher diversity index, reported as 5.84 and 4.59 respectively compared with the index values of downstream left and right area that are 4.16 and 2.89 respectively (Table 2). Kohli et al. (2004) documented a decline in weed richness from 25-12 from *P. hysterophorus* non invaded sampling site to high invaded sampling site of lower Himalaya (India). Similarly, Adkins and Sowerby (1996) documented that *P. hysterophorus* have allelopathic impact in its shoot and root leachates and thus has ability to reduce growth rate and produce of many related species. The reason of decrease of species richness is documented by Navie et al. (1996).

Table 2: The species, Simpson Diversity, Shannon Diversity, Evenness and Richness index of weed Species in upstream and downstream level at Head Qadirabad.

Diversity Indices	**USL**	**USR**	**DSL**	**DSR**
Species	48	37	33	22
Simpson (D)	0.98	0.97	0.97	0.95
Shannon (H')	3.83	3.55	3.43	3.05
Evenness (E)	0.96	0.94	0.94	0.96
Margalef (R)	5.84	4.59	4.16	2.89

Conclusion: The present study concludes that parthenium is rapidly colonizing Agri-forest wetland at Head Qadirabad of the district Gujranwala, sudden effort are necessary to control its diversity and impact on the natural diversity of wetland.

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Availability of data: We have included all data in the manuscript that were collected during the field survey.

Authors' contributions: Umair has designed project, collected data and written this article; while Abbasi, Muhammad and Khan critically analysis this article and approved as final.

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