'Top 50' national rankings in mathematics

With 2012 being the National Year of Mathematics, it will be meaningful to assess where India stands in the national rankings using data from the *Essential Science Indicators*^{SM} database (http://esi.webofknowledge.com/home.cgi) from Thomson Reuters, covering the period 1 January 2001–31 October 2011.

We start with an initial list of the top 50 countries ranked according to citations. Table 1 shows the rankings according to what we call the zeroth-, first- and second-order indicators of performance, namely the number of papers, citations and exergy. In this case, predictably, USA tops all rankings. Note that in Table 1, the number of articles, *P* and citations, *C* received are for the time window

Table 1. Countries ranked by various performance indicators

Rank	Ranking by papers		Ranking by citations		Ranking by exergy	
1	USA	74,874	USA	366,539	USA	1,794,359
2	PEOPLES R CHINA	36,146	PEOPLES R CHINA	111,986	FRANCE	427,900
3	FRANCE	26,377	FRANCE	106,239	PEOPLES R CHINA	346,950
4	GERMANY	21,078	GERMANY	84,647	GERMANY	339,933
5	ITALY	15,453	ENGLAND	64,474	ENGLAND	299,683
6	JAPAN	14,412	ITALY	55,968	CANADA	213,575
7	ENGLAND	13,871	CANADA	54,039	ITALY	202,706
8	CANADA	13,673	SPAIN	44,712	SPAIN	157,775
9	RUSSIA	13,614	JAPAN	40,417	AUSTRALIA	133,700
10	SPAIN	12,671	AUSTRALIA	28,928	JAPAN	113,345
11	POLAND	6,703	RUSSIA	22,986	ISRAEL	77,565
12	SOUTH KOREA	6,406	ISRAEL	20,517	THE NETHERLANDS	77,565
13	AUSTRALIA	6,259	THE NETHERLANDS	17,348	BELGIUM	69,345
14	INDIA	5,766	POLAND	16,938	SWITZERLAND	68,136
15	ISRAEL	5,427	SOUTH KOREA	16,794	SWEDEN	61,823
16	BRAZIL	5,175	BELGIUM	16,248	AUSTRIA	61,300
17	TAIWAN	4,169	BRAZIL	16,075	SCOTLAND	53,841
18	THE NETHERLANDS	3,880	SWITZERLAND	14,970	BRAZIL	49,933
19	BELGIUM	3,807	SWEDEN	14,107	SOUTH KOREA	44,027
20	TURKEY	3,379	AUSTRIA	13,725	POLAND	42,801
21	SWITZERLAND	3,289	TAIWAN	12,763	TAIWAN	39,073
22	ROMANIA	3,247	INDIA	11,794	RUSSIA	38,810
23	SWEDEN	3,219	SCOTLAND	11,145	DENMARK	38,792
24	IRAN	3,134	CZECH REPUBLIC	9,395	NORWAY	35,146
25	AUSTRIA	3,073	ROMANIA	8,583	SINGAPORE	32,617
26	CZECH REPUBLIC	3,009	HUNGARY	8,237	FINLAND	32,362
27	HUNGARY	2,925	FINLAND	7,800	CZECH REPUBLIC	29,334
28	PORTUGAL	2,656	TURKEY	7,718	CHILE	24,576
29	UKRAINE	2,522	DENMARK	7,704	INDIA	24,124
30	GREECE	2,376	NORWAY	7,520	GREECE	23,731
31	SCOTLAND	2,307	GREECE	7,509	HUNGARY	23,196
32	FINLAND	1,880	PORTUGAL	7,498	ROMANIA	22,688
33	CHILE	1,634	SINGAPORE	7,085	NEW ZEALAND	21,966
34	NORWAY	1,609	IRAN	6,851	PORTUGAL	21,167
35	SOUTH AFRICA	1,543	CHILE	6,337	TURKEY	17,629
36	SINGAPORE	1,539	NEW ZEALAND	5,632	IRELAND	17,253
37	DENMARK	1,530	SOUTH AFRICA	5,011	SOUTH AFRICA	16,274
38	NEW ZEALAND	1,444	UKRAINE	4,715	IRAN	14,976
39	ARGENTINA	1,387	IRELAND	4,714	ARGENTINA	14,717
40	IRELAND	1,288	ARGENTINA	4,518	SERBIA	12,037
41	SLOVENIA	1,213	SLOVENIA	3,628	SLOVENIA	10,851
42	MOROCCO	1,035	SERBIA	3,410	UKRAINE	8,815
43	SERBIA	966	EGYPT	2,575	EGYPT	7,701
44	BULGARIA	911	SLOVAKIA	2,537	SLOVAKIA	7,167
45	SLOVAKIA	898	BULGARIA	2,501	BULGARIA	6,866
46	EGYPT	861	MOROCCO	2,272	WALES	6,826
47	LITHUANIA	744	PAKISTAN	2,129	PAKISTAN	6,429
48	PAKISTAN	705	WALES	2,082	MOROCCO	4,987
49	WALES	635	LITHUANIA	1,645	LITHUANIA	3,637
50	NORTH IRELAND	181	NORTH IRELAND	346	NORTH IRELAND	661

1 January 2001–31 October 2011. The impact i is then computed as C/P. While P and C are quantity measures (output and outcome respectively), i is inherently a quality measure. One can think of P as being equal to i^0P, and C as being equal to i^1P. Thus P and C can be thought of as zeroth-order and first-order performance indicators. In continuing this as a series of the parameter spaces, the product iC (also i^2P) is an energy-like term (called exergy X), which can be thought of as the second-order performance indicator, and is a scalar measure of the scientific activity during the window concerned that takes into account both quality and quantity. We see from Table 1 that research in USA during this period is far ahead of the other countries. In exergy terms, USA is now nearly four times as active as France and five times more active than China.

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Why does *Apis dorsata* F. forage on brackish water and other non-conventional sources?

The honey bee (*Apis dorsata*) collects a number of substances to ensure its survival such as nectar, which the adult bees convert into honey and store in beeswax cells; pollen, which provides most of the protein, amino acids, fats, vitamins and mineral requirements of a bee's diet; and water, which the bee collects to help maintain the temperature and humidity of the hive and dilute the stored honey for consumption[1]. Besides collection of nectar and pollen, the bees forage for water. They mostly prefer saline, brackish water to fulfil their salt requirements[1]. In an observation recorded during June 2010 in Jammu, India, *A. dorsata* F. was found to collect water from animal wastes flowing outside from animal sheds (Figure 1). The observations were made for seven consecutive days, from 10 to 15 h for 10 min at the beginning of each hour. The number of bees ranged from 3 to 10, with an average of 5.20 ± 1.20 ($n = 42$) bees/min.

Based on this, experimental trials were conducted under caged conditions for five days, in which the bees were given a choice between normal and animal waste water. In order to attract the bees, sugar in the ratio of 1 : 1 was added to both types of water. Forager bees were collected from the field during peak activity hours between 10 and 11 h and starved for 2 h before providing them sugar syrup prepared in normal and animal waste water. The observations were recorded at hourly intervals for 10 min at the beginning of each hour. Of the total number of foragers attracted to both types of water, it was found that on an average 33.33% bees (range 15–55%) were attracted to sugar syrup containing animal waste water and 20% bees (range 5–45%) to normal water, thereby indicating that the sugar syrup containing animal waste was much preferred over normal pure water.

Why do the bees forage on animal wastes? The answer to this question can be traced from the fact that bees have requirement for water, salts and amino acids[1,2], which are available in animal wastes including urine. Approximately 95% of the volume of normal animal urine is made up of water and the other 5% consists of solutes (chemicals that are dissolved in water) which are classified as ions (sodium (Na^+), potassium (K), chloride, magnesium (Mg^{2+}), calcium (Ca^{2+})), organic molecules (urea, creatinine, uric acid) and other substances/molecules found in small amounts like carbohydrates, enzymes, fatty acids, hormones, pigments and mucins (a group of large, heavily glycosylated proteins found in the body)[3]. Thus animal wastes can fulfil the water and chemical requirements of bees, which have been reported to require 10 amino acids for their normal growth[4]. In earlier studies also, a variety of phytophagous Heteroptera, Hemiptera and some tropical butterflies (Lepidoptera) have been reported to feed on non-plant food sources such as bird droppings, dung and carrion[5]. Mateus and Noll[6] found that among bees (Apoidea), the only records of feeding on non-plant food sources involve the members of the tropical subfamily Meliponinae (stingless bees). They occasionally collect faeces and carrion, and *Trigona hypogea* is an obligate necrophage, using carrion instead of pollen as a protein source. Honey bees may sometimes use non-floral resources such as honeydew or bacterially induced plant exudates, but these are to be considered just barely modified plant products. Herrera[7] was the first to report temperate (*Bombus terrestris*) and tropical (*Bombus ephippiatus*) bumble bees feeding on carrion, bird droppings, animal urine and mammalian faeces. A search for sweat has been observed among stingless bees, honey bees and halictid bees[8,9]. The habit of licking sweat was observed in *Apis mellifera* and in *Plebeia* sp.[10]. Some bees have been reported to collect fungal and

Figure 1. *Apis dorsata* collecting water from animal wastes/brackish sources.