

Table 2. The high h -degree countries/territories (h -degree > 6)

Rank	Country/territory	h -degree
1	USA	27
2	Germany	21
3	England	20
4	France	18
5	Italy	16
6	Spain	15
7	Canada	14
8	The Netherlands	14
9	Japan	13
10	Australia	13
11	Sweden	13
12	Switzerland	13
13	PRC	13
14	Russia	11
15	Belgium	10
16	Scotland	10
17	Denmark	10
18	Poland	10
19	SK	9
20	India	9
21	Austria	9
22	Brazil	9
23	Finland	9
24	Norway	9
25	Czech Republic	8
26	Taiwan	7
27	Israel	7
28	Portugal	7
29	Greece	7

Here we use a numerical transform to calculate the h -degree. The h -degree of India is 9, which means that the researchers of the country had more than $9 \times 100 = 900$ funded collaborative articles with the researchers of nine other countries/territories during 2009–2011. In collaboration networks, the nodes with high h -degree mean that they maintain stronger links with other nodes. Thus they are the important nodes which have the capacity to control and organize networks⁹.

collaborations). The graph contains the links whose collaboration strength is not less than 5000 and the 22 nodes which they link.

In the network the core standing of USA is clear-cut. USA maintains strong

collaboration with most other major countries/territories and these partnerships constitute the backbone of the network. Table 1 indicates that USA participates in all the collaboration links whose strengths are ranked in the top 7. In the collaboration links whose strengths are in the top 20, 60% is related to USA. In addition, the European traditional scientific powers such as Germany, England and France, also have many high-strength collaborations with other countries/territories. Overall, the collaborations among the Western powers are close, and those among the developing countries appear to be relatively weak. In Asian countries, only the strength of collaboration links between China and Japan ranks 20th (Table 1). The funded researchers from developing countries tend to seek partners from the Western countries. This is partly because the scientific and technological powers, like USA, dominate in most scientific fields. On the other hand, it is also possibly because the cost of long-distance collaboration can be guaranteed by the funding.

The collaboration network is a typical weighted network. Its link strength represents the collaboration strength and has a significant analytical value. Therefore, the method for measuring the nodes of weighted networks, h -degree, could be further applied^{8,9} (Table 2). The h -degree of a node in a weighted network is h if h is the largest number such that this node has h links such that the weight of each link is greater than or equal to h . In the collaboration network it is equivalent to Schubert's partnership ability index^{10,11}.

Table 2 shows that USA and the European traditional scientific powers have outstanding performance in both the breadth and strength of collaboration. Some emerging countries, such as China, may have great total collaboration. The strength of collaboration links between China and USA ranks first. However, compared with Europe or America, the range of main Chinese partners is narrow,

resulting in relatively low h -degree. For these countries, the policy-makers of funding ought to consider whether an in-depth scientific collaboration of a wider range should be encouraged, in order to avoid the over-reliance on a few countries in the future development of science.

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Plastics – a formidable threat to unique biodiversity of Pichavaram mangroves

Plastics pose a serious threat especially to coastal ecosystems and marine life. Accumulation of plastic waste in coastal zones is spiralling at an alarming rate

and has resulted in unnoticed loss of diversity. One such case is the Pichavaram mangroves and the associated wetlands (11°25'N; 74°47'E) situated at the mouth

of the Vellar, Coleroon and Uppanar rivers in Cuddalore District, Tamil Nadu, India. The mangroves cover an area of 1100 ha, with 51 islets ranging from



Figure 1. Different plastic materials found in Pichavaram mangroves: **a**, Plastic water bottles; **b**, Carry bag hanging from a tree.

10 sq. m to 2 sq. km which are separated by intricate waterways, creeks and channels that connect the estuaries. The southern part of the Coleroon estuary is predominant with mangrove vegetation and northern part of the Vellore estuary is dominated by mudflats. About 50% of the area is covered by mangrove vegetation, 40% by waterways and the remaining filled by sand flats and mudflats, teeming with benthic organisms and water birds^{1,2}. The Pichavaram area is well known for its tourist attraction for more than two decades. Ironically after the 2004 tsunami, some tourists visiting uninhabited islets deep inside the mangroves using unlicensed motor boats hired from the surrounding hamlets³, seem to throw away non-degradable plastic materials such as carry bags, plastic bottles and food wrappers directly in the waterways and the core part of the mangroves, and such abandoned bags and bottles lodge themselves in several location of the mangroves (Figure 1). This reckless attitude has been increasing over the years. The negative impact of tourism on wetlands in bastardizing the fragile habitats has already been reported⁴.

The thrown-away carry bags and plastic bottles cause considerable damage to the fragile mangrove ecosystem and its unique diversity. The evils of carry bags are disreputable. The carry bags are known to clog aerial roots of mangroves, resulting in poor air exchange and sometimes leading to the death of young plants⁵. Moreover, the carry bags which are settled on the mudflats have palpable effects on benthic community and finally devastate the mudflats. The carry bags alter the strength of biological interactions, which leads to the death of fragile benthic organisms and annihilates the habitat. As a result, prawns, crabs, ben-

thivore fish and water birds which depend highly on the benthic organisms for their survival will also be severely affected⁴. Oysters and some mollusc species use the roots of mangrove plants as home and open their shells during the high tide in order to collect their food⁵, but the carry bags which cover the roots may prevent the entry of water leading to starvation, provoke asphyxia and ultimately lead to the death of these species. Other larger marine organisms like the turtles may die after consuming the carry bags by mistakenly recognizing them as jelly fish. It is worth mentioning here that globally endangered turtles including the Olive Ridley (*Lepidochelys olivacea*) are effectively utilizing the east coast of India as potential habitats.

The closed plastic water bottles which float on the surface of the water during tides and moderate wind may frighten the birds and alter its behaviour as well as of other keystone species of mangroves such as crabs. They will also considerably reduce their foraging time, which will alter their behaviour and physiology. It is important to state here that for these species foraging period is significantly correlated with the tidal cycle, and obviously they have a restricted foraging time which they should utilize effectively.

The carry bags, hanging over the mangrove tree branches, produce a peculiar sound during wind flow which cause panic among the foraging migratory and resident water birds and force them to move away from the place. This kind of disturbing events may even force the birds to leave the habitat permanently^{6,7}. In general, migratory water birds are unable to compensate the lost feeding time, which will also affect their energy reserves and migration accuracy⁸. It deserves to be mentioned here that the

excrement (guano) of water birds is a good source of nutrients. It is rich in nitrogen and phosphorus⁹ and plays a vital role in the development of a healthy mangrove system which is otherwise low in dissolved inorganic nitrogen and phosphorus concentration¹⁰.

It is necessary to remove the carry bags and plastic water bottles from the mangroves with the help of local people. A strict ban on the usage of plastic articles in and around the mangroves has to be imposed in order to protect the unique mangrove diversity and for sustainable fishery resources. Furthermore, the state government should impose a moratorium on the usage of carry bags and plastic water bottles in their tourism hotel in Pichavaram and other mangrove wetland areas.

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