initial flush of microbial activity probably results from rapid catabolism of simple soluble-carbon compounds initially present in the wheat straw[4]. After an initial immobilization of N from the added straw, mineralization of previously immobilized N occurs, resulting in a net release of N (ref. 5). The widely fluctuating moisture and temperature at the soil surface induces a variable half-life for the microbial biomass[6]. The recycling of nutrients is the eventual outcome of this microbial growth, death and regrowth. In this process, microbial biomass as an agent of nutrient cycling process serves a dual role: as sink and source for nutrients[7,8].

In a straw managed system, microorganisms may be the primary source of mineralizable nutrients in soil[9] and much of the native soil mobile N may be derived from the dead microbial biomass[7,10]. The amount of N held in microbial biomass may indeed correspond to potentially mineralizable N (refs. 11, 12). In the present study the rate of N-mineralization was greatest in the straw + fertilizer treatment[13].

Results of the present study thus indicate that a combined input of plant residue and fertilizer is a better option for agriculture in the developing countries as it helps build up the active soil organic matter pool for sustained high nutrient supply. The incorporation of residue under reduced tillage will additionally conserve soil moisture[14].

1. Vance, E. D., Brookes, P. C. and Jenkinson, D. S., *Soil Biol. Biochem.*, 1987, **19**, 703–707.
2. SPSS/PC, SPSS Inc., Illinois, USA, 1986.
3. Ocio, J. A., Brookes, P. C. and Jenkinson, D. S., *Soil Biol. Biochem.*, 1991, **23**, 655–659.
4. Knapp, E. B., Elliott, L. F. and Campbell, G. S., *Soil Biol. Biochem.*, 1983, **15**, 319–323.
5. Allison, F. E. and Klein, C. J., *Soil Sci.*, 1962, **93**, 383–386.
6. Carter, M. R. and Rennie, D. A., *Plant Soil*, 1984, **76**, 157–164.
7. Jawson, M. D., Elliott, L. F., Papendick, R. I. and Campbell, G. S., *Soil Biol. Biochem.*, 1989, **21**, 417–422.
8. Singh, J. S., Raghubanshi, A. S., Singh, R. S. and Srivastava, S. C., *Nature*, 1989, **338**, 499–500.
9. Amato, M. and Ladd, J. N., *Soil Biol. Biochem.*, 1980, **12**, 405–411.
10. Marumoto, T., Anderson, J. P. E. and Domsch, K. H., *Soil Biol. Biochem.*, 1982, **14**, 461–467.
11. Paul, E. A., *Plant Soil*, 1984, **76**, 275–285.
12. Bonde, T. A., Schnurer, J. and Rosswall, T., *Soil Biol. Biochem.*, 1988, **20**, 447–452.
13. Singh, Hema, Ph D Thesis, BHU, Varanasi, 1992.
14. Holland, E. A. and Coleman, D. C., *Ecology*, 1987, **68**, 425–433.

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The life-cycle of potato vector, *Myzus persicae* (Sulzer) in India

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Eggs of the potato main vector, *Myzus persicae* were collected for the first time from India. This aphid was earlier known to reproduce parthenogenetically. Its different morphs showed 11 and 12 chromosome numbers.

MYZUS PERSICAE is the chief aphid vector of several potato viruses[1], the most important being potato virus Y (PVY) and potato leafroll[2]. Due to these viruses, potato yields are reduced by 40 to 85 per cent. A complete knowledge on its complicated life-cycle is very essential, so as to have effective control[3]. Males and oviparous females of this aphid were earlier described from India[4] which otherwise mostly reproduces asexually.

Mating and egg laying have now been observed for the first time on peach trees (*Prunus persica*) at Modipuram, Meerut, during February and March 1992. The mating lasted for about 5 minutes. The eggs were laid in the crevices of axillary buds in clusters. Some eggs were also laid on the twigs. These were first greenish in colour and later turned shining black.

Cytological studies of the sexual forms collected from peach trees and asexuals from potato crop were carried out by subjecting them to air-dry Giemsa stain method[5]. The results are presented in Table 1. These morphs either had chromosome numbers $2n = 11$ or 12. Males were formed on the secondary host plants like potato and flew to the primary host plant (peach) for mating. The gynoparae (which form oviparous females) also fly to peach trees. Here males are X0 and are produced parthenogenetically through a specialized meiosis in which only X chromosome undergoes

Table 1. Chromosome numbers in different morphs of *M. persicae*

Peach	Potato
Males $2n = 11$	Clone Asexual female (apterous) $2n = 11$
Asexual female $2n = 12$ (alate)	Clone Asexual female $2n = 12$ (apterous)
	Asexual female $2n = 12$ (alate)

reduction division[6]. Thus production of sexuals might have taken place through any of the above asexual forms. The detailed cytological studies on the reproductive behaviour will form an interesting pursuit of a hitherto unknown aspect of these aphids under Indian conditions.

1. Kennedy, J. S., Day, K. F. and Eastop, V. F., *Commonwealth Inst. Entomol.*, London, 1962, p. 114.
2. Broadbent, L., *Biol. Rev.*, 1953, **28**, 350–380.
3. Moran, Nancy, A., *Annu. Rev. Entomol.*, 1992, **37**, 321–348.
4. Ghosh, L. K. and Verma, K. D., *J. Aphidol.*, 1990, **4**, 30–35.
5. Kurl, S. P. and Narang, R. C., *Curr. Sci.*, 1978, **47**, 837–838.
6. Blackman, R. L. and Hales, D. F., *Chromosoma*, 1986, **94**, 59–64.

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Helpers in cooperatively breeding small green bee-eater (*Merops orientalis*)

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A three-year study of breeding behaviour in the small green bee-eaters (*Merops orientalis*) conducted in and around Bangalore, revealed that in 40% of the nests studied, a solitary helper assisted the breeding pair in nesting activities. In such nests the duration of the nesting was significantly reduced and the number of chicks fledged per nest was significantly higher. It was also observed that nests with helper were more during the season following poor rainfall than those following good rainfall.

OVER 300 species of birds are known to exhibit co-operative breeding behaviour where an auxiliary (non-breeding adult) typically assists the breeding pair in rearing their young[1]. Such a behaviour has been recorded for at least five species in India (Table 1). Such altruism appears, at first sight, to be paradoxical under the Darwinian theory of natural selection. The most important advance to explain such paradoxical behaviour is the theory of inclusive fitness[2]. The central idea in Hamilton's theory is that fitness comes not only from rearing ones' offspring but may also come from caring for ones' genetic relatives. In other words, altruism is not paradoxical since it is nepotistic, i.e. directed preferentially towards genetic relatives[3].

Table 1. Indian birds exhibiting cooperative breedin ;

Name	Source	Year
Chestnutheaded bee-eater *Merops leschenaulti*	Pappanna, per. commun.	1990
Small green bee-eater *Merops orientalis*	This report	1992
Jungle babbler *Turdoides striatus*	Gaston, A. J.[9] Zacharias, V. J.[10]	1976 1978
White-headed babbler *Turdoides affinis*	Zacharias, V. J. and Mathew, D. N.[10] Praveen Karanth, K. and Sridhar, S. unpublished	1978 1990
Pied kingfisher *Ceryle rudis*	Rayer, H. U.[11] Sridhar, S. and Karanth K. P. unpublished	1980 1989

The bee-eaters (family Meropidae) are alert and vivacious birds, distributed in tropical Old World. They specialize in catching bees and related hymenopterans. Of the 24 species of bee-eaters in the world, 11 are reported to exhibit seemingly cooperative breeding behaviour[4]. The small green bee-eater, *Merops orientalis*, has eight races, easily the most geographically variable among bee-eaters with slight plumage variation. They are common in open cultivated fields, nest on face of perpendicular banks of canals and ravines, sandy river banks and sandy bunds and gently sloping bare grounds, around cultivated tracks. The nests are in loose colonies, with a distance between any two nests being more than 10 m. The nesting season around Bangalore is February–August, with peak breeding around April–May. Only one helper is seen with a pair, arriving normally after the completion of nest excavation or beginning of incubation and staying with the breeding pair, even after the chicks have fledged.

A total of 24 pairs were observed for three years (1990–92) during breeding months (February to August) at GKVK Campus of the University of Agricultural Sciences, in North Bangalore (13° N 77° E, rainfall 890 mm; altitude 930 m). Three nests were observed daily for 2 h (4.00 PM to 6.00 PM) from the period of nest site selection till the chicks fledged, while the other 21 nests were observed twice a week.

Birds visiting the nest were marked using indelible nontoxic dye for identification. To do this we erected mist net in front of the nests under excavation during night. When the birds leave the burrow or approach the burrow the next morning they became harmlessly entangled in the nets. After taking measurement we put the non-toxic dye (Fevicryl fabric paint), different colours for different individuals caught at each nest. Frequency of food provisioning by individuals (parents and helper) in nests with and without helpers was recorded. Data on each stage of the breeding cycle which included duration of nest digging, incubation, feeding the chicks and feeding the fledglings were also recorded. The average duration of each stage of nest cycle was taken for determining the time spent on primary nesting activities (excavation, incubation and feeding). The peak breeding period was determined by finding out the months in which maximum number of active nests were observed compared to previous months.

Nest digging activity in small green bee-eaters, commenced around mid-February and excavation was completed in 15 to 20 days. A lag period of 5 to 10 days was noticed before egg laying and incubation. The period of