Not only do they increase their chances of mating with the receptive female by donning her scent, but they actually seduce, and lure, normal males away from her.

In garter snakes, courtship takes place in writhing mating swarms, or balls; each female is courted by many mates (see figure). Mason and Crews report that many of the mating swarms they studied lacked females; instead, one of the males was being courted by the others. These courted males, or 'she-males' are morphologically indistinguishable from true males, and have higher levels of testosterone and lower levels of oestrogen than true females. Yet these she-males have active female-like pheromones: the pheromone from the skin of she-males is as effective in eliciting courtship from males in experimental arenas as is the pheromone extracted from the skin of females. She-males, however, are not as sensuous as true females. When males are given a choice between a female and a she-male, only about 20 per cent of the males court the she-male. Nevertheless, she-males have a tremendous reproductive advantage. When groups of males and she-males are allowed simultaneously to court an attractive female, approximately 70 per cent of the trials end with matings by she-males. Casual observations of mating balls composed of all three classes of snakes indicated that the she-males actually seduce some males and entice them to court the she-male instead of the normal female.

So far only the seductive effect of she-males on 'he-males' has been examined. Such interactions would have predominated in natural populations when she-males first appeared and were the rarest sexual form. Given the reproductive advantage that she-males show in such interactions, the rapid proliferation of she-males seems inevitable. The effect that she-males have both on other she-males and on true females should be investigated. Do she-males interfere with the reproduction of other she-males to an even greater extent than they do with males? Do females treat she-males differently from he-males? Also, are there ecological factors that limit the viability of she-males? If behaving like a she-male truly entails no costs, however, then an evolutionary problem emerges: why aren't all males she-males? The answers to these questions will be necessary for a complete understanding of the phenomenon Mason and Crews have described. □

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Daniel I. Rubenstein is Assistant Professor of Biology at Princeton University, Princeton, New Jersey 08544, USA.

This engraving of an American white pelican by John James Audubon is included in the reissue of six engravings of North American birds and in an exhibition at the British Museum of Natural History. Both mark the bicentenary of Audubon, North America's most famous naturalist. His *Birds of America,* consisting of 435 hand-coloured plates, was first published in London between 1828 and 1839. Audubon travelled over the whole United States, painting life-size pictures of native birds, many never described before. The plates were engraved on Double Elephant (991 × 673mm) copper sheets and one edition of 200 copies was printed. Most of the plates were destroyed but the American Museum of Natural History owns 12, six of which have now been restored. The money raised by selling the new issue will finance an Audubon fund at the American Museum of Natural History. The exhibition at the British Museum of Natural History, entitled "Drawn from Life", runs from 3 July to 28 September, 1985.

Stellar evolution

Brown dwarfs and hidden mass

from R. J. Tayler

Is it possible that much of the hidden matter in the solar neighbourhood and elsewhere in the Universe is composed of brown dwarfs, low-mass subluminous stars that do not become hot enough for nuclear fusion reactions? Until recently no brown dwarfs had been identified. Now infrared observations suggest that the star Van Biesbroeck 8B is such a brown dwarf. On page 42 of this issue L. A. Nelson, S. A. Rappaport and P. C. Joss support this identification by providing detailed calculations of the possible structure and evolution of this star.

It is generally agreed that stars whose masses are less than about a twelfth of a solar mass, the precise limit depending on the chemical composition and on some uncertainties in the physics of stellar interiors, do not attain a high enough central temperature for a useful release of nuclear energy. As a result they have only a short life as stars with significant luminosity, whereas stars whose masses are just above the limit have a very long main-sequence lifetime. The process of star formation is complex and not very well understood; it is not clear whether large numbers of stars will form below the mass limit, although some studies of the fragmentation of gas clouds have suggested that the minimum stellar mass formed might be significantly smaller. If that is true, a substantial amount of matter in the Universe could be in the form of these subluminous stars, the brown dwarfs.

There appears to be hidden mass throughout the Universe. More than fifty years ago, Oort pointed out that the strength of the gravitational field perpendicular to the disk of the Galaxy in the solar neighbourhood implied a local mass density greater than that provided by luminous matter. Although much interstellar gas has been discovered since then, there still appears to be hidden mass in the solar neighbourhood. In addition, the variation of rotation velocity with distance from galactic centres implies that many galaxies have higher masses than expected. Finally the dynamics of groups and clusters of galaxies indicates the existence of hidden mass on a much larger scale. It is difficult for all of this matter to be baryonic, if the hot big-bang cosmological theory is valid, but some of it certainly can be, so it is of interest to ask whether brown dwarfs are an important constituent of the Universe.

Brown dwarfs must be difficult to detect unless they are close to the Sun and previous discussions of their probable numbers has been based on estimates of the numbers of low-mass luminous stars. For masses close to and greater than that of the Sun, the number of stars in unit-mass range in a given volume of space increases rapidly with decreasing mass. This mass function must turn over at some low mass so that the total mass in the solar neighbourhood is not impossibly large, but the crucial question is whether this turnover occurs above or below the limit for nuclear reactions. Observers are not agreed on this point. G. Gilmore, N. Reid and P. Hewett (*Mon. Not. R. astr. Soc* **213**, 257;