

principle, to establish a permanent base on the moon, a minimal station like the Antarctic base. Beyond that, it would be necessary to recreate an ecosystem where the essential raw material needs (including air, water, and food) could be extracted on site or recycled. Actually, we cannot consider applying the current method on a large scale, where almost everything must be brought from earth via costly launches.

Ecosystems of this type were studied by the Russians first (the first experiment was in 1961) and by the Americans, namely with Biosphere 2, a greenhouse 1.3 ha in surface area, planned to maintain in closed circuit (with an outside power supply) a set of plants and animals, including the presence of eight people. This experiment, which was carried out initially using private funds, was unjustly criticized by the press and a portion of the scientific community. In fact, despite certain "amateur" sides, it has already contributed a great deal: during an initial two-year experiment from 1991 to 1993, four men and four women lived almost entirely self-sufficiently, demonstrating the validity of the principle. The recycling of water was total, while the recycling of air was imperfect (it was necessary to add oxygen after fifteen months of total isolation), and the production of food slightly inadequate (the inhabitants of the biosphere left thinner, having started in on the reserves).

After another six-month experiment, the structure was taken over by the University of Columbia, which seems interested especially in the ecological aspect, to the detriment of the space application. However, it is a descendent of Biosphere 2 who could represent the future autonomous moon base of the middle of the next century. A human settlement on the moon is first of all a scientific necessity, namely for astronomers. It is also a springboard into space. Almost all the materials necessary for the construction of stations and spaceships can be found on the moon, the exploitation of these resources will be much more economical than on earth because the reduced gravity and the absence of atmosphere on our satellite enable an easy and sure launch into orbit.

Human expeditions will necessarily follow automated missions to Mars, if for no other reason than to verify the past existence of traces of life. As for the development of permanent Martian colonies, this can be envisioned, but one can also imagine skipping this step, by creating artificial planets. The idea was conceived by American physicist O'Neill, who studied in detail cylindrical structures 30 km in length by 6 km in diameter, in rotation to create an artificial gravity and able to shelter millions of people in an earth-type biosphere.

These artificial planets could be constructed in the asteroid belt, between the orbits of Mars and Jupiter, where we find an abundance of materials that are easy to exploit, which will be able to provide numerous chemical bodies, including oxygen and water.

In longer term, and when the industrial-scale manufacture, storage, and use of antimatter is mastered, smaller models of these same craft will be able to leave the solar system. They will be able to reach the vicinity of another star, after a voyage of several centuries, during which generations will succeed one another in these "ship-worlds" (unless we have mastered human hibernation by then).

These migrations probably will not take place until after reconnaissance [missions] conducted by automatic probes [have been completed]. The preferred destinations would obviously be systems where a planet supposedly shelters evolved life.

Imagine that a human expedition settles in the asteroid belt of a system where a civilization exists that is quite probably at a lower stage of technical development than ours (if the reverse is true, it is likely that the contact was already made via telecommunications, or else that the most advanced civilizations made the voyage before us): for ethical reasons, but also in the interest of a serious scientific study, it could not afford to intervene openly, at the risk of inducing a fatal culture shock. The study should