

# Among Our Contributors

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one of the most interesting newcomers in the field, has appeared in this magazine previously and had a story in Fredrik Pohl's STAR SCIENCE FICTION NO. 5.

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equally prominent in the mystery field as the creator of the inimitable Solar Pons pastiches, is of course the author of some superb material in the Lovecraft tradition.

## **GORDON R. DICKSON —**

appears only once in Don Day's monumental Index to the SF magazines 1926-'50. Since then, he has appeared in every magazine in the field and is the author of several novels.

## **JOHN BRUNNER —**

prominent British SF and fantasy writer and novelist, makes one of his rare appearances in this haunting story about the adventures of Gerald Howson, Psi.D., Curative Telepath First Class, W.H.O. The sequel will appear next month.

## **LESTER DEL REY —**

needs no introduction to any reader of SF and fantasy.

## **WENZELL BROWN —**

author of more than twenty novels about contemporary matters makes, we believe, a first appearance in the field with this article.

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distinguished British physicist and space-travel authority, writes on SPACE PHYSICS in an article published here through the courtesy of Mr. Sam Moskowitz, former editor of SCIENCE FICTION PLUS.

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# planet of waste

by LESTER del REY

THE FIRST piece of fiction I ever wrote began with the idea that in a green and lovely world the last of the human race lay dying. Sometimes now, twenty-two years later, I wonder whether I will ever have to begin a serious fact article with the same words. Then I realize that this can never happen—because the green and lovely world will also lie dying.

The tragic fact today is that there are valid reasons to assume that man is passing an irrevocable death sentence upon himself and upon all other life forms which will leave the planet a literal wasteland. This is not only possible within our life-span—it is being done at this very moment, without need of war or violence as an excuse.

Let me say at once that I am not greatly concerned with the standard, overpublicized dooms of war or peace. The cry of "Wolf!" has rung through the air since ancient times, but the

flock still seems to graze unperturbed on the hillside.

Most dooms fortunately carry their own safety valves. Overpopulation can create untold misery, but will be checked automatically by the decimation of starvation and a new balance will be struck. A plundered world can somehow be rebuilt when the need becomes urgent enough, since the basic chemical elements cannot escape from a planet. The most virulent plagues capable of withstanding environmental dangers have never overcome man's incredible powers of resistance, and laboratory plagues are only variations nature has already tried before.

Even the danger of atomic warfare may prove a doubtful threat to man's survival as a race. Weapons capable of killing off both the enemy and the user have existed before, and somehow they have not been used. To either forest-dwelling or plains-living tribes, fire is as sure a doom as atomics to us; fire was therefore never

used except with the most careful controls. Somehow, even the madmen of the tribes were not permitted to use such fire wantonly. There is at least a chance that civilization may ultimately prove as prudent as barbarism, so far as war is concerned.

Nevertheless, the atom lies at the root of the danger. It can theoretically yield tremendous knowledge and contribute to life's ancient need of energy, but it carries with it a unique by-product known as waste, perhaps with almost poetic insight.

It was recognized long ago that an organism—and even many chemical reactions—will tend to die in a concentration of its own wastes. Yeast gains energy by turning sugar into alcohol, which is the waste by-product; when the alcohol concentration is too great, the yeast cannot survive. Here life forms which burn sugar to carbon-dioxide have a clear advantage, since this gas is more difficult to concentrate.

Until now, man and many higher animals could overlook this rule because the wastes produced were ones which did not tend to concentrate, or ones which man could escape or destroy. But now technology has produced a waste totally unlike any life has experienced in concentration before. (The creation of life initially seemingly could not have occurred had there been a high level of radioactivity even a billion years ago.)

Any isotope at all which is unstable—and hence emits dangerous radiation during its breakdown—may be considered as poisonous to life, though uranium-235 and plutonium are considered so desirable that they are not removed as wastes. At the current time, a lot of attention has been focussed on strontium-90, largely because of its spectacular spread; but actually it is no different in its nature from any other isotope—it is a radioactive by-product, or waste, of a release of energy from the atom. An atomic pile which uses the same

amount of uranium as the bomb ultimately does may even yield a larger amount of wastes than the explosion does.

These wastes are created whenever matter is fissioned for energy or for other isotopes. Uranium breaks down into a great many different isotopes during fission. Eventually, these contaminate the uranium "fuel", and must be removed. The uranium or plutonium are carefully pulled out of the mess, but this still leaves a great deal of dangerous material which cannot be destroyed.

Hence, the use of our methods of atom-cracking for power will inevitably produce by-products which may prove dangerous to the race.

Nobody at this stage is going to suggest that all atomic fission be stopped (though the testing of bombs may not be permitted because of its spectacular dangers). But when any action is potentially dangerous, we expect certain logical examination of the situation on the part of the one taking the action. We don't even permit the use of normal firearms without precautions dictated by such an examination of the dangers and needs involved. Surely we should examine this new factor as carefully.

Precisely how great is the danger from any given amount of atomic fission, particularly from the level of activity now going on? And is the need great enough to justify the risk involved?

Those questions must be asked, and the risk and the need must be balanced against each other. If the need is great enough, even a calculated risk of doom may be taken; otherwise, no greater danger than is surely tolerable can be permitted. And since the presence of danger alone makes examination of the need mandatory, that seems to indicate that the risk should be examined first.

That risk has recently become far more pressing than we had previously believed. Prior to the latest dis-

coveries, it had seemed that there was almost no danger below a certain so-called "safe" level of radiation. This "safe" level was reduced considerably with experience, proving a faulty examination of risk before, but the idea remained. Unfortunately, it seems untrue.

All radiation is dangerous, at any level! The latest discoveries indicate that any level of radiation, however weak, imposes some danger. The normal background radiation level of the earth—the lowest possible level with which we can deal—is itself somewhat dangerous, though not enough to eliminate life, of course. It has been estimated, however, that two million lives may be cut short annually by this low level; much of this is through damage to germ plasm that results in children who cannot survive either through birth or through a normal life span. The idea of a safe level must then be shown as ridiculous. All that can be said is that there is a level below which the body can seemingly repair the gross damage done it by radiation; even then, the results may show up much later in the individual, let alone in the delicate cells that carry the future of the race. Any raise in the background level in which man lives means the shortening and the loss of lives.

Additionally, there are dangers in some cases that exceed the apparent level. Several isotopes are ones which tend to be concentrated. Plants will draw them from the soil and concentrate them; animals concentrate them still more; and finally the men who eat the meat or animal products concentrate them still more. In some cases, local concentrations in the body are also set up. Swedish scientists found local spots in the bones where strontium-90 was 60 times as strong as its average in the body—and hence, capable of 60 times the damage to red-cell producing bone marrow. This is true of radioactive iodine and several other isotopes as well as of stronti-

um-90. Hence, even the level of gross-safety may be only 1/60th as high as once was thought.

The obvious answer to this would be man's old one—either get rid of the wastes or escape from them. But it isn't that easy.

There is no way to destroy a radioactive isotope, except to wait until it decays into some safe isotope by itself. Here the half-life (ranging from minutes to many millenia) doesn't end the danger, but only halves it, of course. Men can do nothing about ending the breakdown of such atoms. Heating, freezing, alloying or compounding them produce no discernable change. Spreading them out avoids local concentration, but increases the background level for the whole world.

The only way to escape would be to leave the world, which is dear to all of us in science fiction. This involves a tremendous amount of time with a tiny segment of the population. We'll be lucky to land on Mars before the end of the century, and we most certainly won't be colonizing any planet within our lifetimes.

The one thing we can do about these wastes is to concentrate them and attempt to put them in some safe place, away from any great danger of affecting people. This is what is being done in the more careful methods of disposal of wastes today, though not in all cases. Some atom-cracking plants still release wastes through stacks into the air on the outmoded theory of "safe levels"; others release wastes into the rivers and seas, on the idea that they will be again deconcentrated below safe minimum levels.

A great deal of waste products, however, are disposed of in some attempt to answer the problem. Huge storage tanks have been built to handle the sludge, and in some cases the problem of finding a place for more storage is becoming acute already. Other wastes are concentrated in a dry form and sunk into the ground or

dumped in containers into the sea. In a few cases, tank trucks carry sludge to the sea and it is ferried out far beyond the shore.

It has even been proposed that dry salt or oil wells be used as dumping grounds.

So far as I can find, few scientists are satisfied with any of these disposal plans. The sea offers such a bad choice from current knowledge that it can only be covered in a separate article. England, where sea disposal has been the chief method, is already finding areas in the near waters where fish are showing a very high concentration of dangerous isotopes.

Underground storage in tanks implies that the activity level will reach "safe" levels before the tanks deteriorate. The faith in the tanks is as touching as the hope implied. I can't help wondering about what would happen in the case of a minor earthquake or even one of the trifling adjustments underground that might cause a leak.

But the chief trouble with the whole idea is that we have no real knowledge of what constitutes a safe place, or how safe this really is. We have no experience with long-range shielding of large concentrates of radio-active elements. Neutron-emitting breakdown is something difficult to isolate, since the neutrons must go somewhere; and what happens if the tanks or concrete blocks themselves become sufficiently "hot", or the neutrons begin to wander into surrounding territory? How sure can we be that dumping into oil wells will get rid of the wastes, when we don't know yet how much diffusion really occurs under the surface? We know that the "waters of the earth" underground do a tremendous amount of shifting things around—more than we thought a few years ago—but not how much.

The physicists are worrying heavily about the horrible inadequacy of waste disposal under the best system. But a lot of waste is not treated with

any great care. Industrial plants use more and more isotopes. These are often disposed of by such simple means as washing them down the drain. No adequate controls are in force here—and these wastes are as deadly as any others.

Recently, to drive home the difficulty, a can marked as for A. E. C. Waste Disposal turned up on shore. The news later announced that it was empty, but the shock reactions following its discovery indicated how very real the danger from it was considered by those controlling such things.

Certainly, the background count is rising. We had no really accurate world-wide picture of what it was before Hiroshima, but its rise is obvious. By no means all of it is coming from bomb testing, either. In England not long ago, a fission installation belched tremendous amounts of dangerous wastes from its stacks, and territory for a great distance around showed a spectacular rise in radioactivity. Apparently this was an accident—but even such accidents must be considered an inevitable part of the whole business of cracking atoms.

As a further cheerful thought, it's worth considering that we have no real surety of the permanence of the shielding of the atom plants themselves. Remember that if an atomic plant were to close down today, it could not be safely broken into for centuries to come, because of the level of energy already built up in its basic structure. Add to that the fact that Hanford nearly broke down during wartime through changes in the structure inside the shield, caused by only partly understood side effects of the radiation. Under heavy radiation bombardment, a great many substances seem to change form, and to lose their normal strength. Here we deal with what is practically an unknown factor.

If we add the submarines and near-future airplanes driven by atomic

power to the plants, and realize how subject these are to accidents, we can readily see where the count of radioactivity may be raised fantastically.

We can't count on the breakdown to make up for fresh additions, either. Even at the present level of atom-smashing, we are accumulating dangerous isotopes at a rate fantastically out of proportion to the rate at which their own activity renders them harmless.

One of the surprising things to anyone unfamiliar with the subject is the extremely low concentration—that is, the very tiny amount of such isotopes—needed to exceed minimum safety levels. The discussion of the dangers from fallout make it seem as if hundreds of thousands of tons were needed to blanket the earth with such results. Yet in reality, the total amount of strontium-90 produced by bomb testing should be measured in ounces and pounds, not in tons at all!

Yet in many areas, from that tiny amount of deadly substance, grain and milk showed concentrations that were almost as high as the most optimistic safe levels—and from ten to a hundred times as great as some scientists believe permissible!

Unlike other poisons, the wastes don't lose their danger on use, either. If a thousand men were to pass an area exceeding fatal levels at the rate of one a day, the thousandth man would be no safer (except for very slow decay of activity) than the first. If strontium-90 concentrates in the bones of a baby, it still is involved in raising the general background level of Earth.

Actually, there is no way to be sure of the danger. Explanatory biology (as opposed to the biology of classification) is a very new science, having found some keys to cell behavior only very recently. Real nuclear physics didn't get started until two decades ago. Ecology hasn't successfully been

applied to man in general yet. And medicine was so unaware of the full danger of atomic or other radiation that few doctors today bother to keep an accurate record of total X-ray exposure of patients.

But the scientists are gravely concerned, so far as we can learn from those either free enough or brave enough to express an honest opinion. In Sweden—where no vested interest in atomics by the government permits greater freedom and objectivity—the worry has reached near-panic levels. Nor is Sweden alone. Even in the United States, men have issued warnings so grave that the papers have felt obliged to play them down to "protect the public"!

I have read varying estimates of the danger. One very optimistic one indicated that at the present level of fission (1958), the year 2000 would see 10,000,000 deaths caused by artificial radioactivity. I've seen other accounts that placed the figure at seven times this. They are all guesses. The figure could be only a single million and be appalling, because the year 2100 would then almost certainly see the rise of mortality exceed the total birthrate.

The danger to the race will be greater than the danger to the individual, also. For one thing, growing children are going to be the ones most affected; their bodies are accreting materials and storing them in growth, and their bones will reach for strontium-90 as readily as calcium. Then these younger people are going to be the ones where genetic damages are most severe, since they will pass on germ plasm damage acquired during early years to the next generation.

This whole subject of mutation is itself a matter of controversy, but the most optimistic guesses of trained biologists are not pleasant to contemplate. A damage done to a single individual by radiation might conceivably effect thousands within a few

generations. We know that mutations were already being caused by background radiation—and we know that the great bulk of such mutations are harmful or lethal. The chance of superman from radiation is so tiny that it would certainly be unworthy of discussion, but the chance for man to mutate toward extinction is very real.

In this country, of course, the A. E. C. controls everything dealing with the subject of any importance, and provides jobs or opportunities (some indirectly) for most of our scientists working on the subject. And the A. E. C. has taken a view of the whole subject which makes the danger seem minimal, at worst, and hardly worth considering. Needless to say, most of our scientists have given public utterance to the same position, though some private comments have indicated greater doubts.

Let us admit at once that the A. E. C. probably has more information available to it than any other group in the world, and not gloss over its optimism without examination. But let's also recognize that this is not merely an agency for the control of atomic processes and dangers. True, it serves as our policeman on the subject. But it also serves as the body having the job of keeping us obviously ahead of all others in the development of bombs and power plants. Most of its appropriations go to causing fission, and only a tiny part to controlling the results. At the head of it are men who do not have the formal training in the methodology of science, generally, but rather are practical politicians. It polices itself only, and its influence is in proportion to the amount of wastes it creates, effectively, not to its predictions.

Few would question the intent of the body. But its record in estimating danger must cast a grave doubt on the reliability of its current stand. It has been forced by facts to make a very tardy but drastic downward revision of "safe" minimum levels already on

several occasions. Its estimate of fallout proved grotesquely wrong. And generally, it has been the last body in the world to accept unpleasant facts about radiation, or has refused to face them. In addition, its reluctance to release knowledge to the public for fear of "needless fright" makes me reluctant to accept its releases as being representative of its own current opinion.

As a result of our official position being more optimistic than that found elsewhere in the world, we have embarked on a huge program of building atomic reactors, not merely for defense, but also for power and for sale to the rest of the world. This means that the current level of production of wastes must rise rapidly and any danger from the present course will be magnified. The guesses for the danger in 2000 are already out of date, and we may find it necessary to raise the estimate ten or a hundred fold before that date arrives.

Frankly, I'm not at all sure how careful some of the technologically less advanced countries will be when they receive reactors made by us. In the rush to get into atomics, disposal of waste may be given very short shrift, and some of these plants will probably be contaminating our Earth for all of us far more rapidly than those under direct A. E. C. control. Maybe we'd better revise our danger figures up that ten or hundred fold by 1980 instead of 2000.

Incidentally, the damages done won't be pleasant ones. The rise in radiation levels will make themselves felt in the cases of stillborn or defective children, in more and more cancer among younger and younger people, especially in the dread form of leukemia, and in other of the more horrible forms of death. The degeneration of the race through harmful changes will be less obvious at first, but even more horrible when it becomes obvious—because by then, it may be too late to do anything!

In other words, nobody can speak with any certainty of the degree of danger, but there is a possibility that we are gambling with the total and horrible destruction of the race.

It's a possibility of graver nature than we have ever faced, even in war. Certainly only a very pressing need could justify such a risk. Is there such a need?

The need for materials of war is the first answer that comes to mind. Here the decision to a large extent has been taken out of the power of anyone except top level policy makers, and there is certainly room for considerable disagreement. However, once a nation has sufficient hydrogen and A-bombs to wipe out any enemy completely as an effective enemy, how much can additional atomic development add to this power? The best estimates are that we already do have enough of such weapons to annihilate any country opposing us. I feel somewhat reluctant to add to the risk of survival to gain the power to wipe out such an opponent ten times or more—because I still consider death a one-time affair, and have no evidence that ten destructions are more final than one.

Anyhow, the need for war materials alone might be tolerated, provided the war itself did not create havoc. We could probably tolerate the amount of radiation from wastes developed in the making of bombs, since this effort would tend to fall off as our stockpile of bombs increased.

Actually, this is not the only reason for our work in fission. More and more of the wastes are being created from purely peace-time atomic efforts. In the near future, when we begin using the power piles we are developing, the danger will almost certainly come mainly from such non-military installations.

Research and necessary isotopes for medicine and industry account for

some of this development, supposedly. The value of such isotopes is unquestionable, but the need will be a lot smaller than one might think. One plant capable of recovering a major portion of isotopes, rather than dumping most as dangerous wastes, could be designed to care for most real needs. For a lot of industrial uses, isotopes are simply more convenient or cheaper ways of doing what older methods could still accomplish.

However, the real goal of our tremendous drive toward more and more installations is the supplying of atomic power. And here, where most of the danger will arise, the need seem minimal, at best. In fact that need is so slight that in this country the power reactors must be subsidized by the government, since they cannot otherwise hope to compete with other sources of power. The cost of an installation will make the interest per killowatt come to a higher figure than the entire production cost per killowatt by other means. Water power is still probably the cheapest source of power, and has added advantages from control of the water supply to surrounding areas.

Have we begun to exhaust our water power possibilities. There seems no question that we have not. A great many such plants could be put up, except that the money for the projects is not available—though it is available for the less economical atomic fission plants.

Nevertheless, there can be no question but what mankind is using more and more power, and will continue to do so. Something must be done to increase the available supply of energy, and our coal mines are not going to last forever, nor are the oil wells we have been draining; it takes three hundred million years to make an oil field, but only a century to exhaust it.

Man, of course, is the only animal capable of great waste. He wastes without provocation. He enjoys it,

and sets himself up above other men by his capacity to waste more than they do. He has improved his talent in this more than any other talent. It took 2500 years to turn Etruscan Italy's fecundity into the late Roman malarial swamps. But in only 400 years, he has leached out a huge rich continent, nearly exhausted the Mesabi range, created dust bowls in the center of the country and replaced the cone-bearing pines of the forests with cone-bearing signs advertising useless wood-pulp luxuries. In the last ten years, while crying about the coming exhaustion of oil, he has increased the horsepower in his automobiles from under 100 to over 250, and has refined the engines to accept only the highest-octane-rating gas.

So there is little question but what he will find ways in which to exhaust his main sources of power within finite time—darned finite, in fact.

Normally, that might seem to justify building the atomic reactors. But does it? Just what percentage of the coming need for power will be met by the reactors?

By 2000, when the pinch for oil, coal and water power might begun to be felt—they will last until then, certainly—the chances are that his current rate of reactor production might make a little difference—but not much. A hundred power reactors would be of little importance compared to the power drains today, and a thousand would offer no real end to the coming power shortage. In fact, if all the reactors used in calculating the worst prediction of doom were to be in use, they would not equal the power still available from developing hydro-electric potentialities, nor even come within 10% of it.

Furthermore, our current power reactors are not the ultimate in either practicality or possible control of wastes. It would seem that without an immediate pressure for more power, it might be possible to build only enough power reactors to test and de-

velop them into better form, and then to put off building others until the need was great enough to justify any remaining risk.

There are other angles that indicate the wasted oil may not leave as great a power vacuum by 2000 as might be thought. We have just begun to make any serious attack on the problem of getting direct solar power—which might provide energy in tremendous amounts. The current cost is high and the efficiency low, but the return per dollar has been increased tremendously since the war. Since there is no danger attached to this, however, it would seem worth developing with at least some of the intensity devoted by the A. E. C. to fission.

Also, fusion begins to loom as a potential source of far better and cheaper power than fission. At the present time, the attack on peaceful uses of fusion has only been scratched, though we have moved from outright impossibility to fair probability within five years. Here, the breakdown wastes of uranium fission are not produced. When fusion power—through plasma research or otherwise—is attained, there will be no problem of waste disposal, from all we know.

The estimate for a final breakthrough on this indicates it will be developed by 1985—which would still give us enough time to go into production of power through this means by the time the need for extra energy sources becomes drastic.

In any event, the fission reactors themselves can be no more than stop-gap affairs. If oil and coal are limited in nature, so is the available uranium and thorium supply. If called upon to yield the energy demands extrapolated for the future, that supply will carry us for perhaps less time than the sources of power uranium will replace.

The danger is impossible to figure, but the possibility of complete suicide for the race takes such a high or-

der of possibility that it cannot be overlooked by any logical mind. The need that justifies taking such a dangerous calculated risk remains so small that logic would dictate even a 1% fatality rate utterly insane.

In fact, if a new chemical fuel deposit were discovered which could yield more and cheaper power than all the uranium on earth, and if its burning produced a toxicity in the air fatal to one out of ten thousand, no plants would be built until it could be tested fully and made safe. The need would never be considered enough to justify the end. Even the most optimistic scientists capable of objective thinking on this subject would never dare to call the need-to-risk ratio so favorable in the case of atomic wastes.

Maybe we should stop making jokes about the stupid pride involved in Russian roulette. It stops being funny when we are all involved in the game.

Up until now, the one thing man couldn't find a way to waste successfully was himself. He sometimes tried, killing off huge numbers of himself, but there were always more than before to replace the losses. Now he has achieved even this ultimate success. He *can* waste himself completely without any need for violent exertion or any conscious thought. He can even waste his seed through germ plasm damage that will eliminate his race forever.

He not only can do that; he *is* doing it!