Production and Reproduction

Stealing the health of future generations

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Contents

	Preface	4
	Foreword	6
1.	**Reproduction and reproductive risks**	**8**
	Reproduction: a complex, delicate, continuous process	8
	Fertility	9
	Male	10
	Female	13
	Reproductive “mishaps”	16
2.	**Old and new workplace toxicants**	**23**
	30 chemicals of very high concern for reproduction	23
	Lead, a past but still very present poison	23
	Mercury – no level is a safe level	26
	Carbon disulphide: excitation leads to depression	29
	Solvents: ubiquitous and hazardous	30
	The health care sector: when prevention pays	31
	Seeing the wood through the trees	33
3.	**Community legislation: moving jobs preferred over eliminating risks**	**35**
	An incoherent and ineffective jumble	36
	Market regulation	36
	What REACH adds	42
	Prevention at the workplace	47
	The Pregnant Workers Directive: ineffective and potentially discriminatory	50

4. **Better prevention of work-related reproductive hazards** **53**

The United States: trade unions and feminist groups join forces for direct action 54

An obstacle course 56

Workers, key actors in prevention 57

A sectoral approach is key 60

Include reproductive risks in national prevention strategies 62

The international dimension of action against reproductive hazards 63

5. **Conclusion** **67**

References 69

Preface

In traditional societies, the most frightful curses are usually heaped upon fertility. The relentless misfortune that besets future generations is portrayed in Greek tragedy and recounted in biblical narratives. Some present-day working conditions seem equally cursed. But there is no divine whim or fate at play here. The employment relationships that determine these working conditions are what afflict reproduction in different ways. And the victims are not evenly distributed throughout all sections of society or all countries in the world. Here, as in so many other areas of life, working conditions are the root cause of wide social inequalities in health.

Reproductive hazards are a vast and complex mix. They are wide-ranging in nature – chemicals, ionizing radiation, vibration, heat, biological agents, stress, and more – and have equally wide-ranging effects – male or female infertility, miscarriages, birth defects, impaired child development, etc. These risks are largely disregarded. There is probably no other sphere of health and safety at work in which the available information is so piecemeal and lacking.

How many men and women are exposed to such risks in their working lives? What proportion of all reproductive health damage is caused by occupational exposures? How many children are born with a health potential undermined by the reproductive hazards to which their parents were exposed? The consensus among specialists is that these problems are going very largely unrecognized. There are real methodological difficulties, but the main obstacles are political and social. Our production system plunders and despoils nature, and this does not stop where human reproduction starts. Where chemical hazards are concerned, very many substances are being put on the market whose effects on human health have not been properly assessed beforehand.

Also, reproductive risks have often been addressed by discriminating against women, barring them from a number of jobs under the guise of protecting future generations.

This publication aims to help improve awareness of work-related reproductive risks. It reviews and gives a broad-brush picture of the available knowledge for a general readership. It forms part of the general work of our institute to develop a critical trade union approach to health and safety at work. This particular brochure focuses mainly on chemicals, but also touches briefly on other reproductive risks. With the reform of chemicals marketing rules (REACH) under way, we see a vital need to develop better workplace preventive health policies because REACH will address workers' and public demands only if a number of conditions are met. These include reforming the legislative framework and having better prevention policies on work-related reproductive risks. Trade unions have a key role in raising awareness among men and women workers, setting priorities, organizing action and informing the formulation of company and industry prevention plans at national or European level.

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All comments and information on practical steps taken against work-related reproductive hazards will be welcome, and the institute's website will be updated regularly to include it.

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Foreword
The thalidomide tragedy, an unheeded wake-up call

A child born with a birth defect, a miscarriage, difficulty conceiving, impotence or a loss of libido are personal tragedies lived in private by couples and families. Tragedies that may be assumed to have individual, or even family or genetic causes.

Up to the 1960s, the placental barrier was universally thought to protect the foetus from harm from outside substances. It took the thalidomide scandal to elicit an admission that irreversible injury could be done to the unborn foetus unbeknown to the parents by teratogenic drugs and chemicals[1].

Thalidomide was synthesized in 1954 and was marketed as a sedative from 1957 under different names: Contergan in Germany, Softenon in Belgium, Distaval in the United Kingdom (William, 1987; Lenz, 1992; Nay, 1992). The drug won an enthusiastic reception as a safe aid to sleep without the risk of overdose carried by barbiturates. In Germany, it was even sold over the counter, like aspirin.

In 1959, the first severely deformed babies born without arms and legs were reported. There was no suspicion at the time that medication might be responsible. The number of cases began to rise and were reported more or less worldwide. The culprit was finally identified in 1961 as a result of conclusions reached simultaneously by a German paediatrician and an Australian doctor. Medicines containing thalidomide were withdrawn from the British and German markets in November 1961.

In some countries, like Brazil, Canada and Belgium, thalidomide remained on sale until stocks ran out. The United States was spared thanks to the vigilance of Doctor Frances Kelsey of the Food and Drug Administration (FDA), the US agency that grants marketing approval for drugs. Her suspicions had been aroused by the fact that thalidomide acted differently in humans and animals, and by the inflammation observed in the extremities of long-term users. Frances Kelsey was honoured by President Kennedy "for having spared the United States a major tragedy".

It was later learned that the harmful effects of thalidomide appear only when the drug is taken between the 35th and 49th day of pregnancy. The absence of arms, for example, is observed only where the drug is taken between the 39th and 41st day. Some mothers who took the drug

[1] The adjective "teratogenic" comes from the Greek word *teratos*, meaning monster. It describes a substance or preparation capable of producing or increasing the frequency of non-hereditary congenital malformations or birth defects in offspring.

only once gave birth to babies with no arms… Taking the drug for the entire time of foetal vulnerability had particularly serious consequences. Most thalidomide victims were stillborn or died within their first year. The survivors – more than 10 000 across the world – suffered especially limb defects (arm, legs, feet, etc.) and internal organ malformations (heart, kidney, stomach, etc.).

There is a before and after to thalidomide. It led the United States to considerably tighten its rules on the marketing of drugs and post-marketing surveillance of side effects. Drugs now had to be tested on pregnant animals (fertilized females), for example. It prompted new drugs legislation in several countries, especially in Europe. Doctors and their female patients are now certainly more cautious about drug-taking during pregnancy. But what of chemicals that may be present in the environment or at the workplace unbeknown to the public and workers?

In 2000, American scientists showed that some chemicals could cause a wide range of impairments in children, with physical defects as only the most visible evidence (Weiss, 2000). Some substances can cause foetal brain damage, neurological and behavioural deficits and slightly lowered IQ. One reason for their concern was lack of knowledge of what causes most of the impairments and defects observed in children and the scant information available on almost all the thousands of chemicals found on the market.

US scientists are not alone in their wondering. At the same time, the European Commission launched Europe's "battle" to push through the REACH regulation for improved control over chemicals marketed and produced in the European Union.

1. Reproduction and reproductive risks

The term "reproduction" covers all aspects of procreation. A "reproductive risk" arises where a couple's ability to complete a pregnancy is impaired. Reproductive risk factors may affect a man or woman's fertility, as much as the conception, carrying and birth of a child. The term "development" refers to gestation, i.e., the maturation and growth of the embryo into a foetus, infant and finally child. Developmental disorders, referred to as congenital anomalies or malformations, may occur in organs like the heart or limbs, but may also result in a cognitive deficit which will often be measurable only in childhood.

Reproduction: a complex, delicate, continuous process

Pregnancy is a supreme moment in reproductive life, and normally the expression of a couple's desire for children. But getting pregnant is a stage in a long process, which starts when an egg (ovum) is fertilized by semen (a spermatozoon). The egg and spermatozoon are also referred to by the single term, gamete, or even germ cell. All a woman's eggs are present at birth, and carry the maternal genes. Genes are the building blocks of hereditary characteristics. They are assembled in more complex cell structures, called chromosomes. The eggs are contained in the ovaries and are released during each ovulation, i.e., at the rate of one egg a month between puberty and menopause.

The spermatozoa carry the father's genetic information and are produced in continuous cycles in the testes in a process that takes on average 80 days and starts at the onset of puberty. The testes and ovaries are also known generally as the gonads. When fertilization occurs, the fertilized egg implants in the uterus. A normal pregnancy lasts 40 weeks. Up to the end of the second month of pregnancy, the product of conception is referred to as the embryo, thereafter the foetus. The baby's birth is followed by the breast feeding period. The growing child eventually reaches puberty and able in turn to procreate.

Reproductive life is therefore a continuum artificially separated into stages for the purposes of study, but also because these stages act as points of reference. All stages of reproduction are important and may be disrupted by individual, social, genetic or medical risk factors. Exposure to physical or chemical agents present in the home and workplace may

also harm reproduction, as can ergonomic factors like night work or rotating shift work. The box below charts the main stages of reproductive life, each one open to developmental risks. Two aspects of reproductive life are more specifically involved with the work environment: male and female fertility and "mishaps in pregnancy, especially malformations of the embryo and foetus.

Particularly critical development periods

Gametogenesis (sex cell formation)

Egg and sperm production are controlled by hormonal stimulation. The hormonal process can be disrupted by a substance acting on the pituitary gland, hypothalamus or gonads. Gamete production may also be affected. The consequences will be a reduction in the quality and quantity of sperm, subfertility and even infertility in the man or woman.

The pre-conception period

In this period, factors like malnutrition or extreme stress, but also chemicals or medication can disrupt the hormonal process by delaying ovulation or lengthening the menstrual cycle. These factors can also produce a loss of libido in both women and men, and even cause male impotence.

Fertilization

In 50 to 70% of cases, the loss of an unborn child through miscarriage is probably due mainly to chromosomal abnormalities (incorrect number or abnormal structure of chromosomes). Epidemiological studies show a link between occupational exposure and an increase in miscarriages. Unfortunately, the influence of work-related or environmental factors on this specific stage of reproduction remains under-researched.

Pregnancy

The embryo then the foetus is vulnerable to exposure to toxicants all throughout the pregnancy. The placenta is not a certain-sure barrier. The type of vulnerability changes at each point in gestation. The embryonic period, in which the organs are formed, is already well under way when the woman's pregnancy is confirmed by a doctor. Toxicants can cause women to miscarry, give birth to premature, low-weight or disabled babies, and significantly increase the risk of neonatal mortality.

The postpartum period (the period after childbirth)

Some toxicants which the mother was exposed to during pregnancy or after giving birth may enter her milk and risk poisoning her child.

Fertility

The world population is adding 77 million people each year, but fertility in the industrialized countries has been in freefall for several decades. While most of this fertility decline is due to attitudinal changes combined with economic and social factors (the spread of contraception, in particular), the decline in human fertility cannot be airbrushed out of the picture.

The medical definition of infertility is the failure to become pregnant after a year of normal sexual relations without the use of contraception. In the United States, between 10 and 15% of couples are infertile by this definition. In France, 14% of couples have sought medical advice on a fertility problem. The number of pregnancies achieved through assisted conception has risen sharply in a number of European countries. At this point, however, it is not possible to separate what share of this increase is due to improved medical provision and what to any decline in fertility. To explore the matter further, French and Danish researchers launched a cohort study of a thousand couples in 2007 (Inserm, 2006). The pilot

study's initial findings confirmed the harmful effects of smoking on fertility. The researchers hope that the completed study will bring to light other environmental factors involved in damaging reproductive health.

Male

Male infertility is diagnosed from the results of semen analysis. Sperm abnormalities are classed into three categories: azoospermia, or no sperm; oligoasthenospermia, or a low count of poorly motile (slow swimming) sperm; polyzoospermia, or too many sperm. While the causes of male infertility may be genetic, they are more often acquired: infection, trauma, disease (certain medical conditions like diabetes) or toxicants (medicines, smoking, drug-taking, alcohol intake, etc.).

The workplace may be a key source of exposure to these risk factors. Work-related causes of male infertility are usually classified into three groups: psychological factors (stress); physical factors (excessive heat, ionizing radiation, microwaves, testicular trauma); chemicals (heavy metals, pesticides, solvents, organochlorine compounds, hormonally active chemicals). The reprotoxicity of substances like lead and carbon disulphide is well-established, but the researchers highlight two relatively recent events that have heightened awareness of the harm being done to male fertility.

The first is the discovery in 1977 that a pesticide – dibromochloropropane, or DBCP – may cause damage to men's ability to reproduce. The harmful effects of DBCP were identified by workers who used it. At the time, about thirty workers in a division of the Occidental Chemical Company based in Fresno, California, employed on manufacturing DBCP, a pesticide then in common use in fruit orchards, and especially banana plantations. It emerged from locker-room chat that they were no longer able to father children. They found out from scientists at the local university that experimental research had revealed DBCP to have mutagenic and carcinogenic properties. Some studies had even shown up effects on animal reproductive systems. Some of the workers then went for sperm analyses. The findings showed them to be azoospermic and oligospermic (no or low sperm count).

DBCP was taken off the market in the United States and most Western countries in 1979 but continued to be used in Hawaii – for pineapple growing – and Latin America up to the mid-1980s. In 1992, 4000 farm workers in Costa Rica made infertile by DBCP dropped legal proceedings against several US companies in return for compensation. In 2004, 16 000 former plantation workers in Nicaragua maintained their claim for damages against several US firms (Dole, Dow Chemical and Shell Chemical) for irreversible health damage caused by DBCP. On 6 November 2007, a Californian jury ordered Dole to pay US$ 2.5 million to six Nicaraguan banana plantation workers suffering induced infertility.

The other event was the publication in 1992 of the results of a Danish study of nearly 15 000 men, confirming the decrease in sperm quality over the previous 50 years (Carlsen, 1992). The researchers considered their findings to be particularly worrying in light of the concomitant increase in congenital genitourinary abnormalities like testicular cancer.

The investigation into the causes of this situation implicated hormonally active chemicals present in the environment, called endocrine disrupters.

Male infertility and industrial toxicants – DBCP was no exception

After the DBCP affair, the focus of scientific attention shifted from the teratogenic and embryotoxic effects of chemicals to other substances that might affect men's ability to reproduce. A research study published in 1981 reported a range of toxicant-induced impairments of testicular function in US workers employed on synthesizing another pesticide, chlordecone.

Oligospermia, impotence and infertility were identified among Russian boric acid production workers, while sexual dysfunctions were also reported in ferro-manganese production employees. Women not occupationally exposed to vinyl chloride married to men who were showed a higher risk of miscarriages and stillbirths.

Very high exposure to chloroprene – a chlorine halogenated compound – results in reduced sperm motility and sperm count and a higher rate of spontaneous abortions, not to mention the well-known effects on testicular function of chemicals like carbon disulphide and lead, or ionizing radiation.

Source : R. Lauwerys, S. De Cooman, Risques pour les fonctions testiculaires provenant de certains toxiques industriels, *Louvain Médical*, 1981, 100, p. 197-203.

- Endocrine disrupters

Two books fuelled the gradual awakening to the effects of endocrine disrupters. In a book entitled *Silent Spring* published in 1962, Rachel Carson warned of the dangers of excessive use of pesticides (Carson, 2000). "For the first time in the history of the world", wrote the American biologist, "every human being is now subjected to contact with dangerous chemicals, from the moment of conception until death. In the less than two decades of their use, the synthetic pesticides have been so thoroughly distributed throughout the animate and inanimate world that they occur virtually everywhere. (...) These chemicals are now stored in the bodies of the vast majority of human beings, regardless of age. They occur in the mother's milk, and probably in the tissues of the unborn child". She singled out the widespread use of dichloro-diphenyl-trichloro-ethane, or DDT, a chlorinated hydrocarbon synthesized in 1874 whose insecticidal properties were discovered in 1939.

It was while trying to measure DDT in marine animals that a Swedish chemist discovered that other substances – polychlorinated biphenyls generally referred to by the acronym PCBs – are also pervasive in the environment. These chlorine compounds first came into commercial use in 1930 for their industrial properties as non-flammable electrical insulators and lubricants. They were used as insulators in electrical transformers and condensers, and as lubricants in turbines and pumps, or as constituents of oils, adhesives, paints, etc.

DDT has been banned in several countries. It is still used – in Africa especially – in the fight against malaria. PCBs have not been produced in the European Union since 1986, but large quantities of PCBs are still contained in many older electrical appliances which can contaminate workplaces and the waste disposal industry.

The other book, *Our Stolen Future*, published by American zoologist Theo Colborn in 1997 (Colborn, 1997) makes the first-ever reference to "hormone disruptors"[2]. It collects his observations and those of European zoologists on reproductive dysfunctions observed in aquatic fauna and draws comparisons with the Danish researchers' findings on the decline in the quality of human sperm and the concomitant increase in testicular cancer over the past 50 years. Theo Colborn is in no doubt that certain endocrine disrupting chemicals that contaminate the environment are implicated in these disorders. Such substances include DDT, PCBs, dioxins, alkylphenols, etc.

A lengthy chapter of Theo Colborn's book is given over to the tragedy of diethylstilbestrol (DES), a synthetic chemical compound with an oestrogen-like action[3] used from the late 1940s to the early 1980s to prevent miscarriages, but which caused vaginal cancer and uterine malformation, leading to infertility and miscarriages in the daughters of women prescribed it (see p. 20). DES would nowadays be described as an endocrine disrupter.

The disruptive action of a wide range of chemicals on the endocrine system of laboratory animals and some wild species is now fairly well-documented. But the effects in humans are still poorly understood and the focus of controversy. With the DES saga fresh in the memory, however, some States have chosen to err on the side of caution. Evaluations of new drugs and chemicals in the United States must consider endocrine system disruptions. In Europe, the phase-in of the REACH regulation on trade in chemicals is likely to follow a similar approach.

German experts have identified 250 substances with suspected hormonal effects, including organochlorine pesticides, DBCP, some plasticizers like phthalates, alkylphenols, organic solvents, dioxins and PCB, heavy metals like mercury, etc. Some of these products – known as persistent organic pollutants (POPs) – can accumulate over time in the organism and the environment[4].

Population studies on communities living around the polar circle have revealed changes in the sex ratio, i.e., the ratio of the total number of births of girls to boys (Tiido, 2006). These populations are contaminated through a diet very high in fatty fishes which accumulate POPs and particularly PCB. Recent findings suggest that polar circle communities are not the only ones to be affected.

The sex ratio is "naturally" more favourable to males with a ratio at birth of 1.05, i.e., 105 boys to 100 girls. An analysis of birth statistics in Japan and the United States reveals a male births deficit of 127 000 for the former and 135 000 for the latter among the white population between 1970 and 2000 (Davis, 2007). The study's authors conjectured that this deficit might be attributable to a diffuse antenatal exposure to endocrine disrupters. The involvement of hormone action in changes in the sex ratio is established in populations of fathers occupationally exposed to substances like DBCP, some pesticides, lead or solvents.

Endocrine disrupters are found as a group of disparate substances produced or used in large quantities in many branches of economic activity, like the drugs, plant health products and plastics industries.

[2] The preferred term is now "endocrine disruptors".

[3] Oestrogens are steroid hormones synthesized mainly in the ovaries and testicles. They stimulate the development of secondary sexual characteristics in females at puberty, and are thereafter involved in controlling the menstrual cycle. Although oestrogens are mainly associated with reproduction in women, their significance to the male reproductive system and some non- reproduction-related processes (like cardiovascular health and bone formation) has also been established.

[4] The toxicity, persistence and prevalence of POPs prompted more than 150 countries to sign up to the Stockholm Convention on POPs which came into force in May 2004 aimed at the elimination or reduction of POPs. More information: www.pops.int and www.chem.unep.ch/pops.

In July 2005, 130 scientists signed the Prague Declaration on Endocrine Disruption. Seriously concerned about the high prevalence of reproductive disorders in young men and the rise in breast and testis cancers, the researchers called for the tightening up of legislation and more investment in research. In 2002, the European Commission funded a research consortium on endocrine disrupters[5]. The Commission has also drawn up a list of 66 priority substances among 600 suspected substances for more thoroughgoing study[6].

The endocrine system: the body's regulator

The endocrine system refers to the hormonal system that all mammals have. It comprises glands distributed throughout the body, hormones produced by these glands and released into the bloodstream and plasma, and receptors found in many organs and tissues that recognize and react to the hormones. The hormones travel throughout the body, acting like chemical messengers. The endocrine system controls all our biological processes, including brain and nervous system development, growth and the reproductive function, blood metabolism and sugar levels, from conception to death. The ovaries, testes, pituitary gland and thyroid are major components of the endocrine system. Disruption of the endocrine system can occur in different ways. Chemicals can imitate natural hormones eliciting an exaggerated or inappropriately-timed response to the stimulus. Others can paralyse a hormone's effect on some receptors. Yet others can inhibit or stimulate the endocrine system to result in underproduction or overproduction of hormones.

Female

Medically speaking, there are two main causes of female infertility: impaired gamete production, chiefly from disrupted hormone production or regulation, and gamete implantation failure, which may result from infection, trauma (voluntary termination, D&C, IUD), or endometriosis[7].

Research on women long focused on risks to the foetus. The realization that toxicants could also produce hormonal changes that affect other aspects of reproductive life, like the menstrual cycle, ovulation, fertility or miscarriages, came relatively late.

It is now accepted that industrial processes or chemicals that are toxic for reproduction are generally harmful to both sexes. Ionizing radiation is often implicated as one of the physical factors in the workplace that harm women's fertility. Chemicals regularly identified are endocrine disrupters, heavy metals, pesticides, solvents and organochlorine compounds. Women may be more specifically affected by other things like ergonomic factors: carrying heavy loads, poor postures, night work or rotating shift work. Alongside but determined by work are social factors (living conditions linked to flexibility, poverty or insecurity) which are also determinants of female reproductive health.

- **Ergonomic factors**

Physically forceful work is a known risk factor for miscarriages, premature birth and low birth weight. The first study to demonstrate this was done in the 1980s among 50 000 Canadian women (Mc Donald, 1988). The survey revealed a close association between spontaneous abortions (miscarriages) and weight lifting and other physical effort, as well as

[5] More information at: http://ec.europa.eu/research/news-centre/en/med/03-02-med02.html and http://ec.europa.eu/research/endocrine/projects_ongoing_en.html.

[6] List is available at: www.environmentandhealth.org.

[7] Endometriosis is a condition affecting women that occurs when the uterine tissue implants and grows outside of the uterus, i.e., on the ovaries, fallopian tubes, ligaments supporting the uterus and, sometimes on other pelvic organs like the bladder, intestine and vagina.

with shift work, work standing for eight hours a day and extended working weeks (46 hours and over). Other studies, done mainly in Europe, confirmed these findings and added new ones. A decrease in fertility was observed among women doing work that requires intensive, prolonged energy expenditure. The negative influence of tiring work appears to be greater during early pregnancy, in the pre-embryo formation period.

The influence of shift work on pregnancy has been particularly studied among health care staff. A 1996 Swedish study of 3500 obstetrics nurses reported decreased fertility and an increased risk of miscarriage connected with working a three rotating shift system and night work (Ahlborg, 1996). The same study showed an association between night work, premature births and low birth weight. Another study of fertile Italian nurses revealed an increase in menstrual cycle disorders among those working shifts compared to nurses working days only (Costa, 2004). Shift work was associated with a lower number of pregnancies and a longer period to become pregnant. Similar findings were also made by a 1996 European study on rotating shift work, regardless of the type of work done (Bisanti, 1996).

The evidence of all the research done into the effect of working hours and night work on women's reproductive life is that the irregularity of work is more involved than the time when it is done. One plausible explanation is that irregular working hours may introduce a change to the circadian rhythm which would in turn induce hormonal system changes affecting both fertilization and normal development of the foetus. So, a cohort analysis of American nurses identified raised oestradiol[8] levels and reduced melatonin[9] after several years of working nights[10]. The same study also found that two specific patterns of work during the first trimester of pregnancy – consistent night work and extended hours of work (more than 40 hours per week) – were associated with an increased risk of miscarriage.

A large body of research has sought to assess how work-related stress affects reproductive health. Stress *per se* appears not to be harmful, but has a negative influence if combined with other risk factors.

• Social factors

Flexible forms of employment mean that many young people lead uncertain and insecure lives, and materially influence their decision to start a family and have children. A survey of this was done in Tuscany among a thousand young people aged 25-39 employed in one of many "non-standard" forms of work[11]. Of those surveyed, 56% (48% of females and 69% of males) still lived with their parents. Almost all were single. Of those who were in a long-term relationship, 65% thought they would be able to marry or leave the parental home within the following three years, but only 38% thought they would have a child within that period. 62% of the young people in insecure work are women.

A survey done in Rome found that women were increasingly seeing their work as part of their identity, albeit in a more complex relationship than men in which ties to family and children are more involved (Pica, 2005). The women were deeply affected by job insecurity, which

[8] A type of oestrogen secreted by an ovarian follicle, which stimulates the development of secondary sexual characteristics in females at puberty.

[9] A hormone produced by the pineal gland. The secretion of melatonin is reduced by light during the daytime and stimulated during the hours of darkness. It is therefore involved in regulating sleep.

[10] Work schedules and the risk of miscarriage, *The Nurses' Health Study Annual Newsletter*, 2007, vol. 14 (4). *The Nurses' Health Study*, initiated in 1976 by the US Federal agency for medical research (National Institutes of Health) surveys the health of 122 000 nurses questioned in two-yearly cycles. The Nurses' Health Study II recruited a new cohort of 116 000 nurses in 1989, also surveyed on a two-yearly basis. More: www.channing.harvard.edu/nhs/index.html.

[11] *Giovani in Toscana e flessibilità: opportunità formativa e freno alla transizione allo stato adulto*, downloadable from: www.regione.toscana.it/cif/pubblica/lavatip041601/zip_pdf/parte2.pdf.

they perceived as destructive and the first step towards social discontent. The authors argued that the increased number of women-run firms in the Latium region might be a response to the need to escape inevitably insecure paid employment. In a situation where women still acutely feel the constraints of the "double duty" of work and family, single women and childless married women find it hard to fulfil their desire for children. These women do not want to let slip a career opportunity at a time of heightened competition between workers. Given this, it is unsurprising that they should put off motherhood to what they hope will be "the best time".

A national congress on insecurity in Italian universities held in Ferrara in October 2005 brought the eye-opening admission from many women researchers that they had given up on the idea of having a second child, while others had delayed their first pregnancy until they were nearly in their forties. The consensus was that insecurity mainly made it impossible to plan for the future, making life an obstacle course strewn with uncertainties.

Women today – in Western societies, at least – have the right and ability to "control their own body". English women researchers point out that this right can be exercised in practice only if the economic and social conditions are right (Earle, 2007). Some women have little or no choice or control over their reproduction, which is influenced by a combination of social and medical factors like access to health care, family planning, pregnancy monitoring, and infertility treatments. In the United Kingdom, poverty and social exclusion still remain the main determinants of women's reproductive health. The miscarriage and premature birth rate among the poorest women is double that of other social groups. This is not a phenomenon specific to the United Kingdom. A report commissioned by the British EU Presidency in 2005 shows that health inequalities in Europe last from the cradle to the grave (Mackenbach, 2006). The rate of stillbirths and neonatal deaths is higher among the most disadvantaged groups. Children born to families in the lower socio-economic groups on average weigh less at birth, are more often premature or have birth defects.

Infant mortality – i.e., the proportion of children who die before their first birthday – has been a benchmark against which to judge a health system for over a century. Sweden and Japan top the league table with three infant deaths per 1000 births. At the other end, one in seven children in Afghanistan and Sierra Leone dies in the first year of life. While overall infant mortality has decreased in all European countries, differences between social classes remain. A report on social inequalities in health in Ile-de-France (the greater Paris region) found variations in the infant mortality rate within the region (Atlan, 2007). So, the largely poor Seine-Saint-Denis department (north and north-east of Paris) recorded 5.7 infant deaths per 1000 births against a regional average of 4.7 and a national average of 4.4 deaths per 1000 births.

In addition to biological factors related in particular to pregnancies at the lower and upper childbearing ages or family histories of premature births, the study's authors cite social factors like living alone, membership of an ethnic minority community, unemployment, lack of

antenatal care, smoking, symptoms of malnutrition, etc. The evidence of the survey is that the risks of premature birth and low birth weight are higher among mothers with lower qualification levels.

Another aspect is the medical monopolization of reproduction. Many authors have pointed to the medicalisation of women's bodies from birth through motherhood to menopause. These are all lifepoints defined as "medical problems" requiring "expert" opinion and intervention. Medicalisation may be a choice, often demanded by women themselves, but it is exercised at a specific time and place dictated by industrialization, innovation and information. Medicalisation also gives women the illusion of controlling their body and the choice of when they have a child. Many young women are now growing up with the belief that they will have successful pregnancies when they want them. But there are biological and social rhythms that they must obey, which may bring disillusion and misunderstanding. Some infertility treatments may be seen as a loss of control and bring unwanted health consequences.

Reproductive "mishaps"

The scientific and medical focus was initially on birth defects, which are the most visible and doubtless also most grievous of reproductive "mishaps". For the past two decades, the research focus has been on medical conditions arising during foetal development whose consequences are not visible at birth but appear in later childhood or even adulthood, like learning difficulties or types of cancer.

- **Birth defects: an established link with the environment and workplace**

The Eurocat (European Surveillance of Congenital Anomalies) network was set up in 1979 to record the data collected by 43 registers in 20 European countries on over 1.5 million births a year, i.e., approximately 29% of annual births in Europe.

Eurocat estimates that 14% of babies are born with a unique, minor malformation, like a skin tag of generally limited consequences. Approximately 2 to 3% of newborns have a unique but major malformation like spina bifida, a congenital malformation consisting of a defect in the spinal column. Slightly fewer than 1% have multiple malformations. These are the numbers observed at birth. The real number of malformations is substantially higher, and many pregnancies are spontaneously aborted, particularly during the first three months of pregnancy. Some authors estimate that 10 to 20% of known pregnancies end in spontaneous abortion or miscarriage, and that an unknown number of pregnancies are lost even before the diagnosis is made. Furthermore, screening for certain malformations, like spina bifida or Down's syndrome (trisomy 21) nowadays often results in an elective termination of pregnancy in countries where it is permitted.

According to Eurocat, 6 to 8% of birth defects may be due to a gene mutation; 6 to 8% a chromosome abnormality; a further 6 to 8% to an environmental agent. From 20 to 25% of congenital malformations are thought to have a multifactorial aetiology involving both

environmental and genetic factors, and from 50 to 60% have no known cause. It is believed that at least 25% of malformations of unknown aetiology may have an undetected "environmental" cause.

Specialists interpret "environmental factors" to cover a wide range of things including medical (an infection during pregnancy or maternal illness like diabetes or rubella [German measles], for example) and lifestyle causes (tobacco, alcohol, drugs, etc.), socioeconomic status factors (malnutrition) or exposure to toxic substances both in the environment and in workplaces.

A series of studies done in the United Kingdom revealed a link between central nervous system defects and certain occupations: farm workers, drivers, members of the British armed forces, workers exposed to pesticides, solvents or paints. To explore this more deeply, researchers examined paternal occupations in 694 cases of central nervous system defects occurring in Oxfordshire and West Berkshire (Fear, 2007). The results, published in 2007, found an excess of cases only in the children of fathers employed in agriculture, agrochemicals and occupations exposed to animals.

Environmental factors classically related to birth defects

Infectious agents

- Rubella before the 10th week of pregnancy: cataracts and heart defects; from 10-16 weeks: hearing loss and retinopathy
- Varicella: limb hypoplasia, microcephaly
- Cytomegalovirus: hydrocephalus, heart defects and neurological problems
- Toxoplasmosis: hydrocephalus, microcephaly, cerebral calcification and neurological problems

Maternal illnesses

- Insulin-dependent diabetes: central nervous system defects, heart disease and great vessels problems
- Uncontrolled phenylketonuria: microcephaly, heart defects, mental retardation
- Folate deficiency: spina bifida, cleft lip and palate

Physical agents

- Ionizing radiation at high doses in the second half of pregnancy: microcephaly
- Hyperthermia: central nervous system defects especially anencephaly, microcephaly, cleft lip and palate

Drugs

- Thalidomide: cardiac, renal and limb defects
- Diethylstilbestrol at birth: females – vaginal adenosis; males – hypospadia and cryptorchidism
- Warfarin: nose and bone deformations, microcephaly, hydrocephalus
- Valproic acid: spina bifida, facial disfigurements and cardiac defects
- Retinoic acid (vitamin A congeners): hydrocephalus, microcephaly, a wide range of organ defects, especially the heart and vessels

Source : *Special report: a review of environmental risk factors and congenital anomalies*, EUROCAT 2004.
See: www.eurocat.ulster.ac.uk

- **Brain development and exposure to neurotoxic substances**

Are visible malformations merely the tip of the iceberg? A slightly lowered IQ or slightly greater tendency to aggression are less easily attributable to a specific cause than a limb deformation. The focus over the past decade has been on damage that is undetectable at birth but nevertheless real, caused by toxicants. Most frequent of these are brain and neurological system defects that cause behavioural problems and intellectual impairments including dyslexia, ADHD, learning disability,

autism, and so on, affecting 3 to 8% of children. Some of these impairments are due to genetic factors or chromosome abnormalities, others to in utero exposure to medicines, alcohol, cocaine and probably also nicotine. Only about 25% of the causes of neurological development deficiencies are known today.

It is, however, known that antenatal exposure to ionizing radiation above 100 millisieverts[12] may be responsible for learning disability. Embryonic exposure to environmental chemicals can also result in intellectual impairments or behavioural disorders. Cases in point are lead (even at low doses), PCBs, organic mercury and some pesticides. But what other substances might also be responsible for deficiencies, and to what extent? Researchers from the Harvard School of Public Health claimed in November 2006 that chemicals are harming the developing brains of millions of foetuses and children (Grandjean, 2006). They called it a "silent pandemic", observing that only a few substances, like lead and mercury, are controlled with the purpose of protecting children, while the 200 other chemicals that are known to be toxic to the human brain are not regulated to prevent adverse effects on the foetus or a small child.

Until recently, the toxicity of chemicals had almost only ever been studied in relation to adults, almost never in relation to children or embryos. The safety factors generally used to define acceptable daily levels are arguably inadequate to prevent damage in the womb or accumulative or synergic effects. Breast milk, for example, is the ideal nutrient for the newborn, but may contaminate the child with toxic substances accumulated daily by the mother (Lyons, 1999). Polychlorobiphenyls (PCBs), the polychlorodibenzo para dioxins (PCDDs) and polychlorodibenzofuranes (PCDFs)[13] are fat-soluble substances that are not readily eliminated by the organism. As a result, they are stored in fatty tissues and "released" in breast milk. The World Health Organization has organized different rounds of surveys to measure levels of these substances in breast milk to call attention to the health hazards they represent (WHO, 1996).

As a rule, only contaminations sufficiently visible to require medical treatment are identified. For pesticides, for example, an American neurological development specialist has plotted a pyramid whose tip comprises so-called clinical – i.e. visible – effects, the centre being subclinical effects detectable only by neuropsychological tests, and the base by silent, latent effects that will show up only in connection with another health problem or on puberty. Various researchers have suggested that some neurodegenerative diseases (Parkinson's disease, Alzheimer's disease) may originate in events at the earliest stages of brain development.

In June 2006, researchers from different countries meeting in Brescia adopted a declaration to call attention to the neurotoxic effects of metals, and stress the need to reduce exposure to lead, methylmercury and manganese in particular (Landrigan, 2007).

The usually unidentified effects of pesticide use were reported in a study comparing 4-5-year-old children living in two rural farming communities in north-west Mexico (Guillette, 1998). The main difference between the two communities was that one had used pesticides from the late 1940s while the other had maintained traditional farming

[12] The millisievert (mSv) is the unit used to measure the effective amount of ionizing radiation received in the workplace or in diagnostic medical procedures. The EU legal requirement for pregnant workers is that the equivalent dose received by the child to be born must not exceed 1mSv between the time the pregnancy is notified and childbirth. See on this, Sapir, M., Ionizing radiation: what does it mean for workers' health?, *HESA Newsletter*, No. 29, March 2006, p. 19-20.

[13] PCDDs and PCDFs are not produced intentionally but are contaminants formed in particular during the degradation of PCBs, such as during combustion. There are so many of these compounds that they are usually referred to generically as dioxins and furans. Having a very similar chemical structure, these compounds all act in the same way, which accounts for the similarity of their toxic effects.

practices. Umbilical cord and breast milk analyses done in 1990 revealed elevated levels of several pesticides in the former community. A child growth and development assessment was done on children in both communities. It revealed no difference in growth but showed developmental differences. Children in the pesticide-using community scored lower for coordination, short-term memory and ability to draw a person.

Perinatal exposure to toxicants can also harm the immune system – as has been shown with chlordane[14], dioxin and lead – respiratory system, or lead to cancer development.

• Cancers in children and parental exposure to carcinogens

Cancers in children aged under 15 make up approximately 1% of cancers diagnosed each year in developed countries. While much progress has been made in treating these cancers, the same cannot be said for the understanding of their causes. There are big knowledge gaps here.

Approximately 15% of human cancers can be attributed to viral, bacterial or parasitic infections. Links between the papilloma virus and cervical cancer, hepatitis B and C virus and liver cancer, helicobacter pylori and stomach cancer are cases in point. What is known as the perinatal and postnatal period is particularly critical for the future development of several of these medical conditions. Contact with the blood and saliva of its mother may contaminate the newborn with these infectious agents on the threshold of its life.

It is also known that newborns and infants are more susceptible than adults to equivalent doses of ionizing radiation or chemotherapy.

Animal study data show that in utero exposure to a range of toxicants in the prenatal period may raise the risk of developing a cancer in childhood and even adulthood. To date, however, the main uncontested agents are ionizing radiation and diethylstilbestrol (DES), a hormonally active synthetic chemical (see box p. 20).

Making the link between DES and the development of vaginal cancers among daughters of mothers treated with this drug during pregnancy prompted researchers to conjecture that the in utero effects of other hormones might be a causative factor in breast or testicular cancer, for example. To date, this avenue of exploration has not been borne out by epidemiological studies.

Foetal damage by ionizing radiation even at low doses was reported as far back as 1956 in a study published by the English doctor Alice Stewart linking X-rays of pregnant women to cancers – especially leukaemias – in their children (Giles, 1956). Her findings, based on an analysis of the data from the Oxford childhood cancer survey, were hotly disputed at the time, but it is now established that foetuses and young children have a greater sensitivity to radiation than adults on a like-for-like dose basis. Sensitivity is dependent on the dose and stage of pregnancy at the time of exposure. Current medical practice advises against giving X-rays to pregnant women.

Recent data suggest that most childhood leukaemias may originate in foetal exposure but no other agent than ionizing radiation has been formally identified (Anderson, 2000). A number of epidemiological studies, however, implicate parental exposure to other toxicants, especially oil, in the development of childhood leukaemias.

[14] An insecticide placed on the market in 1947. It is a mixture of at least 147 chemical components whose composition varies with the manufacturing process. It has been banned from use in the EU since 1981.

DES – the tragic saga of a "miracle" drug

The 1930s were a time of rapid expansion in the chemical industry, with the discovery of many new synthetic products. Work done by English researchers established that some – which they called stilbestrols – have a hormonal action. Diethylstilbestrol or DES was a notable case in point. The ease – and hence low production cost – with which stilbestrols could be synthesized prompted several drug manufacturing firms to market them and doctors to try out their efficacy against various medical conditions.

In 1946, a husband and wife team of scientists in Boston, the Smiths, published the favourable outcomes they had had in administering DES to help women reduce the frequency of certain complications of pregnancy, like spontaneous abortions, premature deliveries and intra-uterine foetal deaths.

Seven years later, a University of Chicago team published the findings of a comparative study between a group of women given DES and a placebo group. Not only did this study not confirm the Smiths' hypothesis, it actually revealed a greater frequency of some complications of pregnancy among women given DES than those in the placebo group. This study was dismissed by the scientific community and medical schools continued to recommend the use of the drug. Drugs company advertising portrayed DES as a miracle cure, recommended "for routine preventive treatment in all pregnancies".

In 1971, a team of gynaecologists linked DES to cancers of the vagina diagnosed in girls between the ages of 15 and 22 born to women given DES in pregnancy. The frequency of these cancers is about 1 per 1000 among girls whose mothers were given DES. Cancer specialists described these cases as among the most painful they had encountered.

At the end of the 1970s, a new study reported a high frequency of uterine abnormalities among girls exposed in utero to DES, resulting in infertility, an increased risk of ectopic pregnancy, miscarriage and premature delivery which are still today affecting large numbers of women everywhere in the world. They are much more common than cancers.

DES was prescribed to millions of women. It ceased to be recommended for use in the United States in 1971, but continued to be given in Europe until 1983.

A large-scale survey has been done to determine whether the daughters of women exposed to DES in utero are now affected. The findings, published in 2006 by the US National Cancer Institute, indicate later attainment of the menstrual cycle and more irregular periods, a higher frequency of infertility, and a lower number of pregnancies. These findings require further clarification, however.

Sources: Diéthylstilbestrol: des dommages trente ans plus tard, *Revue Prescrire*, 2007, 27 (287), p. 700-702; *DES: questions and answers*, National Cancer Institute, U.S. National Institutes of Health. More: www.cancer.gov/cancertopics/factsheet/Risk/DES

As far back as 1980, a Finnish researcher found a significant excess incidence of cancers among the children of farmworker parents, and leukaemias among the children of fathers who drove motor vehicles (Hemminki, 1980). In a 2005 study of the cases of 22 458 children under 16 who died of leukaemia between 1953 and 1980, a British epidemiologist found a close link between the development of these diseases and an in utero and childhood exposure to discharge gas from oil combustion (Knox, 2005). He singled out 1,3-butadiene[15] but did not rule out involvement by other substances also. He decried the fact that the standard for 1,3-butadiene in workplaces was not designed to prevent cancers in children. A 2007 French study reported a fourfold higher rate of leukaemias in children exposed in utero and in infancy to hydrocarbons (especially benzene), born to parents living near garages or filling stations (Steffen, 2004).

A link between exposure to pesticides and leukaemias in the children of farmers and agricultural workers has been conjectured in a number of scientific journals. In 2007, that link was confirmed in a study

[15] 1,3-butadiene is used mainly in the manufacture of synthetic rubber, thermoplastic resins and styrene-butadiene latex polymers used in paints. It also occurs in oil refinery products and vehicle exhaust fumes. 1,3-butadiene is carcinogenic and teratogenic in animals. It is an International Agency for Research on Cancer Group class 2A substance.

done in Costa Rica on 334 childhood leukaemia cases recorded between 1995 and 2000. The risk appeared more than doubled when the mother was exposed to pesticides during the first two trimesters of pregnancy, but also where she was exposed in the year before becoming pregnant. There was also an increased – but less high – risk where the father had been exposed at the start of the pregnancy (contamination of the home environment) and in the year before conception. The study's authors note that agriculture is a major activity in Costa Rica and is associated with excessive and inappropriate pesticide use (Monge, 2007). In 1996, the country consumed almost four times more pesticides per person a year than the Netherlands, a country known for its heavy use of pesticides.

Germany: excess childhood leukaemias near a nuclear establishment

From 1990 to 2005, 14 cases of leukaemia were observed in children living near a nuclear power plant and research centre located at Elbmarsch, south-east of Hamburg – a rate more than three times that in the general population. The federal and regional authorities tasked a committee of specialists to investigate the possible causes of this excess of leukaemias. A study published in June 2007 raises the possibility that an accident alleged to have occurred on the site in 1986 may be implicated, but dismisses it on the grounds that such an event would be unlikely to have gone unnoticed by the authorities. The excess leukaemia rate therefore remains unexplained for the time being. It is regrettable that no investigation was done into the occupation and possible exposure of the parents of the children affected by leukaemia.

Source: Hoffmann, W. *et al.*, Childhood leukaemia in the vicinity of the Geesthacht Nuclear Establishments near Hamburg, *Environmental Health Perspectives*, June 2007, 115 (6), p. 947-952.

Pregnancy is not the only risk period. Parental exposure to toxicants even before conception may cause cancer to develop in the unborn child. An analysis of exposure to polycyclic aromatic hydrocarbons (PAHs) in the five years preceding conception[16] among the parents of 1218 children affected by brain tumours found an increased incidence of brain cancers among the children of fathers occupationally exposed to PAHs (whether smokers or non-smokers) compared to the children of non-exposed fathers. The children of fathers exposed to tobacco smoke alone also had an increased risk. Occupational exposure of mothers to PAHs, before and during pregnancy, was uncommon, and when found, was not associated with an increased brain cancer risk in their children (Cordier, 2004).

The role of paternal exposure to ionizing radiation in the period preceding conception in the development of cancers in their children remains a hotly-debated issue. The controversy was ignited in the early 1990s by the publication of a study on the children of workers exposed to ionizing radiation at the Sellafield nuclear waste reprocessing plant at Seascale (United Kingdom) (Gardner, 1990). An increased incidence of leukaemias had been observed in the vicinity of the plant. A study of the occupational history of the parents of affected children showed that children of fathers exposed in the six months preceding conception to doses of radiation equal to or higher than 10 mSv (100 mSv accumulated dose) had a higher risk of developing leukaemia than children of nonexposed fathers. Some doubt was cast on the validity of these findings by the failure to find an excess

[16] Contamination by PAHs may result from occupational exposure, exposure to tobacco smoke or air pollution.

incidence of leukaemia in children of the survivors of the Hiroshima and Nagasaki bombings. But comparison alone is not conclusive proof.

Some credence attaches to the idea of "second generation" cancers from pre-conception parental irradiation as suggested by a comparative study of the DNA of children born to parents living in Belarus at the time of the Chernobyl disaster with the DNA of British children. The number of mutations carried by the children but not their parents was double in the Belarus children. The researchers suggested that a radiation-induced mutation in the parents' germ cells may have been passed down to their children (Slama, 2002).

Multi-generation studies suggest that a so-called "genetic" predisposition to cancer may actually be the consequence of an initial in utero exposure to toxicants which is then passed down to subsequent generations (Tomatis, 1992).

More recently, scientists have turned to the origins of life in searching for the origins of adult cancers whose frequency has risen in recent decades, especially breast and prostate cancers. They conjecture that the increased incidence of these cancers might be due to foetal contamination, and that one possible culprit may be Bisphenol A, a known oestrogen mimic since 1936.

Bisphenol A: fears for the health of babies and future adults

Bisphenol A is used in the manufacture of polycarbonates and epoxy resins. Approximately 700 000 tonnes of it are produced each year in Europe, potentially exposing thousands of workers to the chemical. Bisphenol A is used in the manufacture of a wide range of products for the food industry in particular (feeding bottles, water bottles, inner coatings of drinks and food cans, etc.). It is also used in dentistry. It is a major industrial, environmental and food contaminant.

The oestrogenicity of bisphenol A, whose chemical structure is similar to that of DES, has been known since 1936, but only recently have questions been asked about its potential risks to reproduction. In 2007, a group of specialists brought together by the US Centre for the Evaluation of Risks to Human Reproduction (CERHR), concluded that while in utero exposure to Bisphenol A might have neurological and behavioural effects, there was no evidence of other effects.

Very low dose bisphenol A toxicity studies on animals yielded more disturbing results in early 2008, however. They found that bisphenol A exposure during development may produce effects in the prostate gland or mammary gland that might increase the risk of developing prostate or breast cancer in adults.

A new CERHR report published in April 2008 seems to support this conclusion. The report found "some concern for neural and behavioural effects in foetuses, infants, and children at current human exposures". Its authors also have some concern for bisphenol A exposure in these populations based on effects in the prostate gland, mammary gland, and an earlier age for puberty in females.

Following the publication of this report, the Canadian government announced plans to ban plastic feeding bottles containing bisphenol A, which would make Canada the first country in the world to take firm action against this chemical compound. The results of mouse experiments published in May 2008 suggest that in utero exposure to bisphenol A may also increase the risk of adult obesity. This is doubtless going to be a continuing story …

Sources: *Draft NTP brief on Bisphenol A*, National Toxicology Program, National Institute of Environmental Health Sciences and National Institutes of Health, U.S. Department of Health, 14 April 2008, 68 p. (http://cerhr.niehs.nih.gov/chemicals/bisphenol/BPADraftBriefVF_04_14_08.pdf)

Prins, GS. *et al*., Perinatal exposure to oestradiol and bisphenol A alters the prostate epigenome and increases susceptibility to carcinogenesis, *Basic & Clinical Pharmacology & Toxicology*, 2008, 102, p. 134-138.

Soto, AM. *et al*., Does breast cancer start in the womb, *Basic & Clinical Pharmacology & Toxicology*, 2008, 102, p. 125-133.

2. Old and new workplace toxicants

A US Senate report in 1991 (Gao, 1991) documented growing concerns about births and pregnancies prompted by several worrying observations. Recorded infant mortality in the United States was then among the highest in the developed world[17]. About 250 000 of the four million children born each year were diagnosed with birth defects. A growing number of children had learning difficulties. Added to this were 600 000 miscarriages diagnosed each year and 24 000 pregnancies that ended in foetal deaths. 8% of US couples were considered infertile.

The Senate report argued that these different problems had certain common causes related to an easily avoidable environmental exposure to chemicals.

30 chemicals of very high concern for reproduction

After a thorough analysis of the scientific literature, the report's authors compiled a list of 30 chemicals of very high concern for reproduction and pregnancy (see box p. 24). Almost all are found in workplaces.

The Senate report concludes that pre-conception exposure to some of these chemicals may be adverse to fertility, cause miscarriages or harm foetal development. Chemicals identified as hazardous for men were chlordecone, DBCP, tobacco smoke, chloroprene, ethylene dibromide, lead, vinyl chloride, and alcohol. For women, the hazardous chemicals were chlordecone, mercury, tobacco smoke, carbon disulphide, ethylene oxide and alcohol.

It may come as a surprise to see a list compiled at the close of the 20th century still including long-known teratogens like lead, mercury and carbon disulphide.

Lead, a past but still very present poison

The symptoms of lead poisoning have been known for centuries: anaemia, headaches, acute stomach pains accompanied by vomiting and diarrhoea, and the well-known bluish line along the gums. In 1860, a French doctor, Constantin Paul, draw the medical world's attention to what he called the "hereditary mishaps" resulting from slow lead poisoning (Paul, 1860). His interest in the matter had been excited by seeing a patient who had had three successful pregnancies followed by ten

[17] Infant mortality refers to deaths before the first birthday. The Senate report claimed that 10% of US infant mortality may be attributable to low birth weight caused by the mother's cigarette smoking.

Chemicals of very high concern for reproduction

Chemical	Use
Alcohol	domestic and industrial (solvent)
Arsenic	industrial (metallurgy, wood preservative)
Cadmium	industrial (solder, electroplating)
Carbon disulphide	industrial (fumigant, insecticide, solvent)
Carbon monoxide	combustion product (metallurgy, tobacco, car exhausts)
Chlordecone	pesticide (fungicide, insecticide)
Chloroprene	industrial (rubber manufacturing)
DDT (dichloro-diphenyl-trichloro-ethane)	pesticide (insecticide)
DBCP (dibromochloropropane)	pesticide (fumigant, nematocide)
DES (Diethylstilbestrol)	human and animal drug
Ethylene dibromide	industrial (solvent), pesticide (fumigant)
EGEE (ethylene glycol ethyl ether)	industrial (solvent)
EGME (ethylene glycol methyl ether)	industrial (solvent)
Ethylene oxide	industrial (sterilant), pesticide (fumigant)
Gossypol	industrial (stabilizer), food contaminant
Hexachlorobenzene	industrial, pesticide (fungicide)
Lead	industrial (batteries and metal construction)
Lithium	drug, and in fire extinguishers
Mercury	industrial, pesticide (fungicide)
Mirex	pesticide (insecticide, fire retardant)
Nicotine	domestic (tobacco) and industrial (insecticide)
PBBs (polybromated biphenyls)	industrial (coatings, fire retardant)
PCBs (polychlorinated biphenyls)	industrial (electrical transformers, plasticizers)
2,4,5, T (2,4,5-Trichlorophenoxyacetic acid)	pesticide (weedkiller)
TCDD (2,3,7,8-tetrachlorodibenzo P-dioxin)	incineration by-product, pesticide contaminant
Tobacco smoke	
Toluene	industrial (solvent)
Vinyl chloride	industrial (plastics, paper, glass)
Vitamin A	natural substance, drug
Warfarin	drug, pesticide (rodenticide)

Source: GAO, *Reproductive and developmental toxicants*, 1991

problematic ones, including eight miscarriages, after being employed as a polisher in a type foundry for the printing industry. Questioning about her co-workers elicited the information that almost all those who had fallen pregnant had miscarried. Dr Paul also carried out investigations into paternal exposure. His survey of workers in white lead factories, used in paint up to the end of the 1940s, led him to conclude that "death of the foetus or child is symptomatic of lead poisoning, whether it is the father or mother who was exposed to the poison". He also noted that "acute poisoning is not necessary to cause the death of the foetus".

Early 20th doctors in England voiced concerns about the use of lead-containing pills to procure abortions. At the time, it was as great a cause of sickness and death as industrial lead poisoning – which is saying quite something given the huge scale of lead poisoning, especially among workers in porcelain and earthenware factories where pigments

and enamels were lead-based. In 1911, an English doctor, Thomas Oliver, noted that exposed women had three times the number of miscarriages, and that infant mortality was significantly higher where the mother or father "worked with lead". At that time, it was made unlawful for pregnant women to work in heavily lead-contaminated workshops. Even so, lead continued to wreak havoc for several decades after.

Industry's child

At the height of the 1930s Depression in the United States, Annie Lou Emmers wrote to President Roosevelt condemning the devastation wrought by lead poisoning. Mrs Emmers' husband, Frank, was an employee of a pesticide subsidiary of the DuPont Company who had been lead poisoned on the job. Her daughter had been born with extensive physical disabilities and severe mental retardation. She suspected that her husband had brought the lead into their house on his clothing while she was pregnant with what she called "industry's child".

"I've heard of similar babies in the pottery works at Crooksville, Ohio, in the lead mines and smelters of Colorado and Wyoming, in the large fruit orchards where arsenate of lead is used in powerful spraying machines, and among garage workers, handling tetraethyl. How many more are there unheard of? How many babies are crippled each year by lead?", she wrote in her letter to the President.

The authors of the book *Deceit and Denial* in which this letter is excerpted argue that Annie Lou Emmers' letter to President Roosevelt raises important questions. How can people be protected from the actions of powerful multinationals whose activities have, until recently, gone virtually unchallenged and unregulated? How can the poor and oppressed have their voice heard when they speak out about the unequal burden of industrial pollution?

Source: Markowitz, G., Rosner, D., *Deceit and Denial. The deadly politics of industrial pollution*, University of California Press, The Milbank Memorial Fund, 2002, 408 p.

The US lead industry lobbied with remarkable effectiveness to preserve its use in household paint which degrades over time, with damp, or after work, flaking and creating dust that disperses throughout the house and is breathed in by the inhabitants, especially young children. Herbert Needleman, a researcher at Harvard Medical School, found lowered IQ levels in lead-exposed children who displayed no symptoms of poisoning. In 1984, he published an extremely influential article in which he estimated that 678 000 American children under the age of six were poisoned by lead, from paint in particular (Needleman, 1984).

At that time, lead was everywhere in the environment "thanks" to leaded petrol and the ecological vandalism committed by a handful of American firms, including Du Pont, General Motors and Standard Oil of New Jersey. Beginning in the 1920s, these firms gradually imposed the use of tetraethyl lead (TEL) as an anti-knocking additive in petrol, patented by them (Kitman, 2005). The three firms used questionable studies to fend off criticism, and later to delay the replacement and prohibition of TEL. TEL killed many workers in the factories where it was manufactured. It "leaded" the entire planet, producing elevated blood-lead levels in many people, especially children. It was almost completely phased-out in the United States by 1986. In the European Union, the Directive of 13 October 1998 prohibited its sale from 2000[18]. Worse, TEL is still being added to petrol in several of the poorest countries today.

[18] Directive 98/70/EC of the European Parliament and of the Council of 13 October 1998 relating to the quality of petrol and diesel fuels.

Lead use in many industries was to considerably lengthen the roll of victims. In 1984, thirty or so cases of poisoning from lead-rich enamel were documented among workers in a porcelain factory in the Lunéville region of north-eastern France. A year later, in 1985, workers in a battery plant near Sheffield fell victims to poisoning. The women had blood-lead levels[19] between 60 and 100 micrograms of lead per 100 ml of blood (µg/100 ml), the men between 80 and 211 µg/100 ml. But even at this time, workers with blood-lead levels between 60 and 80 should have been transferred away from the job. In 1991, the head of the UK's health inspectorate apologised to the company's employees.

Despite these precedents and an industrial history that bears the imprint of lead-related health scandals, some firms continue to expose their workers to this highly toxic substance.

The Sumer survey of 50 000 employees done in France in 2003 found that the main reprotoxin that workers are exposed to was lead. 0.7% of French workers – 130 000 people – are exposed to lead in battery, crystal glass and pigment manufacture, the production of various alloys, and car radiator repair in garages. France now has some of the strictest standards: special health surveillance must be provided for men with blood-lead levels above 20 µg/100 ml and for women above 10 µg/100 ml.

However, the lead levels recognized as having a health effect are falling all the time. Two American studies, published in early 2008, report adverse effects on the neurological system and intellectual performances of children after antenatal and postnatal exposure to lead at levels between 5 µg/100 ml and 10 µg/100 ml (Jusko, 2008; Gumps, 2008).

Is lead set to become as shunned a chemical as mercury?

Mercury – no level is a safe level

Mercury has a long history of known toxic effects[20]. It is referred to in ancient writings by Hippocrates, Pliny and Galen amongst others. The first cases of mercury poisoning in modern times are described in 1860 among hatters. The character of the Mad Hatter in *Alice in Wonderland* did not spring unbidden from Lewis Carroll's imagination, but from reports of the diseases seen among hatters who used mercury in the making of felt hats.

Mercury and its compounds are highly toxic to humans. Even at low doses, it can damage the nervous system, kidneys and cardiovascular system. It is also toxic for reproduction. The first signs of mercury's toxicity to the unborn child came with the reported high incidence of aborted foetuses among women receiving mercury treatment for syphilis. Mercury was, for several centuries, the treatment of choice for syphilis. It was also used as an antiseptic and bactericide. In 1971, mercury-treated seeds were used accidentally to make bread in Iraq, resulting in 6530 people being hospitalized and 459 deaths. The children of mercury-poisoned mothers have displayed severe central nervous system damage. The second half of the 20th century saw other outbreaks of mercury poisoning affecting pregnant women and newborns. The most infamous is the Minamata disaster in Japan.

[19] Blood-lead levels are expressed as µg/L or µg/dL, according to the country, or, as in EU law, µg/100 ml. The latter measure is used here.

[20] Mercury poisoning is also called mercurialism. Elemental mercury's aspect and colour has also earned it the names liquid silver and quicksilver.

Minamata, a major industrial disaster

In the early 1950s, dozens of people living in fishing hamlets on the shores of Minamata Bay in southern Japan began exhibiting symptoms of neurological and cerebral disorders. The number of cases rose, but it took nearly ten years to realize that they had been poisoned by methylmercury that had accumulated in fish and seafood fished from the bay. The mercury had been discharged into the sea by the Chisso Corporation factory, where it was used as catalyst in the production of acetaldehyde and chlorine. Once in the sea, the mercury was transformed into methylmercury and absorbed by the fish. Methylmercury is a neurotoxin that can easily pass the placental barrier and blood-brain barrier, inhibiting potential mental development. But fish from the bay were the staple of local residents' diet.

Most of the victims died within a short time of being poisoned. Others suffered irreversible loss of eyesight and hearing, loss of motor control, paralysis and tremors. Dozens of children poisoned in utero or through breast milk exhibited serious mental retardation, while others were born blind or deformed.

A Japanese assessment in 2001 officially certified 3000 people as affected by "Minamata disease", of whom 1784 have died. Added to this are another 10 000-plus people suffering central nervous system disorders or potentially affected because of having consumed large quantities of fish and shellfish.

Firms have repeatedly been found guilty by the courts and ordered to pay large sums in compensation to victims. Government, too. In 2004, Japan's Supreme Court found the central government and Kumimoto Prefecture guilty of "maladministration". The Court said the Kumimoto authorities could have identified the cause of the disease in 1959 but did not do so. They failed to enforce the Water Quality Control Act, instead protecting firms that were major employers, held the court.

Mercury has had very many applications in industry: manufacture of measuring instruments (thermometers, barometers), lamps, dry and wet batteries, skin and felt processing, electrolysis in the chemical industry, etc. Workers mainly absorb mercury by inhalation because it vaporises at room temperature, and this has obviously resulted in industrial poisoning.

In 1985, Italian researchers observed that women lamp factory workers exposed to mercury were reporting more menstrual disorders, fertility problems and miscarriages than non-exposed workers in another unit owned by the same industrial group (De Rosis, 1985). In 1991, a New York court jailed the owners of a thermometer factory for exposing their employees to concentrations high enough to cause central nervous system damage.

At the same time, the European chlorine industry lobby, Eurochlor, began to look into the reproductive effects of mercury exposure. An internal document dated April 1991 reviewed the available literature and reported that menstrual disorders, decreased fertility and an increase in miscarriages had been observed among women exposed to mercury vapour at low concentrations (Eurochlor, 1991). The document also reports a study suggesting a possible causal link between paternal exposure to mercury and an increase in spontaneous abortions. This French study, published somewhat later in 1991, had in fact been done in 1984 among a population of 1300 workers in a chloralkali plant using a mercury cell electrolysis process (Cordier, 1991). The study showed that the wives of workers with a mercury concentration in urine higher than 50 µg/L had double the risk of spontaneous abortion compared to workers who were not exposed to mercury.

Mercury is a striking example of how the hazards of work and environmental risks are inextricably linked. The use of mercury by industry has had and continues to have consequences for workers and the environment. Mercury emissions know no bounds. Mercury is persistent and can change in the environment into methylmercury, its most toxic form. Contamination of the food chain by methylmercury has now become a global issue. Those most at risk are pregnant women and young children, particularly in regions where fish and seafood make up a large part of the diet. In 2003, the United Nations Environment Programme (UNEP) set up a special programme to encourage all countries to adopt objectives and take measures to reduce mercury emissions and minimize population exposure. In January 2005, the European Commission adopted a Community strategy on mercury which aims to reduce mercury levels in the environment and human exposure. The strategy comprises 20 actions to reduce mercury emissions and cut supply and demand.

In 2006, the Commission put forward a proposal to ban European mercury exports by 2011. While EU countries have as a whole cut their mercury use and emissions, Europe remains the leading supplier of the chemical. The world's biggest mercury mine is at Almadèn, in southern Spain. It was already being worked in Roman times, and mining operations were not shut down until the end of 2003. But the mine owner, Mayasa, is still recovering mercury from Europe's chloralkali plants in particular. In 1990, the Oslo-Paris Commission (OSPAR), which guides international cooperation on the protection of the marine environment of the North-East Atlantic, recommended that all chloralkali plants using mercury cell electrolysis should be converted to non-mercury technologies by 2010. Some plants have already been converted, but an estimated 12 000 tonnes of mercury are still being used by the chloralkali industry. It is to prevent this mercury flooding the world market that the Commission proposed banning mercury exports and requiring waste mercury to be put into permanent storage. In June 2007, the European Parliament's Environment Committee proposed bringing the ban forward to 2009.

Workers in factories where mercury is still used need to remain vigilant because the occupational exposure limit values set for mercury are indicative in most EU countries. This means that the employer can keep workers working even where airborne mercury concentrations are higher than the value fixed by law. In theory, the exposed workers should be provided with health surveillance, but at most all this does is to assess recent exposure, never the mercury that has accumulated over the years in the kidneys and brain. Transfer away from the job can only be a makeshift solution, therefore, that goes nowhere near addressing workers' legitimate concerns to have their health protected throughout and after their working life.

There is at present no official EU occupational exposure limit value for mercury. The forthcoming adoption of a European directive on a third list of indicative occupational exposure limit values (IOELVs) should plug this loophole. The draft Commission directive on it does include mercury, with a proposed atmospheric limit value of 0.02mg m^3 [21].

[21] Measured or calculated in relation to a reference period of eight hours time-weighted average.

This limit value prompted a general outcry among European employers, who deem it "intolerable".

Extreme caution is also required where mercury is no longer used but where the stored quantities represent a threat to the environment. A threat that may boomerang against workers and their children.

Carbon disulphide: excitation leads to depression

Carbon disulphide, or CS2, is a solvent used in the manufacture of synthetic sponges, viscose and plastic film. It is a building block in the production of many organic sulphur compounds used in particular as vulcanizing accelerators, dyes, pesticides, and pharmaceutical products.

CS2 was discovered in 1796 and rapidly put to many uses, in particular the extraction of perfumes, fats, bitumen and sulphur, the manufacture of waterproof fabrics and rubber. In 1840, it was even tried as an anaesthetic by a Scottish surgeon, but soon abandoned for its undoubted powerful anaesthetic effects were accompanied by hallucinations, headaches and nausea.

In 1860, a French doctor, Auguste Delpech, reported in a note to the French Academy of Medicine his observations of the symptoms afflicting men and women workers in the hollow rubber industry where CS2 was used as a softener in the production of balls and condoms, among other things. In Paris, a considerable number of workers were employed in this industry, "all of whom have become ill or infirm to varying degrees" (Delpech, 1863). Doctor Delpech describes two phases in CS2 poisoning. The first excitation phase is characterized by severe headaches, limb and joint pains, mental disturbance verging on insanity (terrors, hallucinations, agitation), and heightened sexual arousal the remarkable extent of which he said "must be emphasized". Some patients were beset by priapism (constant erections) and licentiousness. Women workers had excessively heavy menstrual flows which Delpech likened to spontaneous abortions. With continued CS2 intoxication, the excitation phase gave way to an abatement phase which he called "collapse". The sufferers became sad, disheartened, indifferent, stupefied almost, and lapsed into imbecility. The senses – sight, hearing, smell – gradually deteriorated, but "among the most serious and troublesome changes is that of genital problems […] in collapse, all the male workers become more or less wholly impotent […] everything is extinguished at once – both the ability to have an erection and the desire for sexual congress". Among women, he noted the same loss of desire and the inability to have children or to carry a pregnancy to term, as well as other changes, in particular "atrophy of the breasts". His observations, made in 1860, were probably the result of exposure to very high doses.

In the 1980s – more than a century after Delpech's observations – researchers at the University of Ghent found viscose factory workers exposed to CS2 suffering a range of eyesight, psychomotor, blood and… sexual disorders (Van Hoorne, 1992). The percentage of workers admitting to sexual disturbance rose with the degree of exposure: 21% for an exposure between 1 and 30 mg/m³ and 28% for an exposure above 30 mg/m³, whereas impotence – affecting 16% of workers

– increased identically regardless of the degree of exposure. The workers were unaware of the health effects of CS2 and would probably never have considered mentioning their sexual disorders had they not been specifically asked about them.

CS2 is still in use. It is classified by the European Union as a category 3 reprotoxic chemical. The expert consensus is now that at an exposure equal to 10 mg/m³, women experience menstrual cycle changes that reflect a hormonal disorder, while higher concentrations may produce spontaneous abortions, premature deliveries or birth defects[22]. Like mercury, carbon disulphide is included in the draft EU directive establishing a third list of IOELVs. The recommended exposure limit is 15 mg/m³ [23].

Solvents: ubiquitous and hazardous

Millions of workers are permanently exposed to solvents everywhere in the world. There are tens of thousands of differently-composed solvents. They are used to clean, degrease, dilute and strip. They act as carriers for other products like inks, paints, insecticides, pesticides, and so on. The past century has seen them come into increasingly widespread use in the iron and steel, chemicals, car making, cleaning and electronics industries. Most of the solvents used are by-products of coal or oil combined with other compounds. They enter the organism through the skin and by inhalation. No solvent is harmless, and some are even carcinogenic, toxic to the liver, kidneys and brain.

In the 1970s, Danish doctors voiced concerns about the neurological impacts of solvents for workers who used them at low doses but daily. Ten years on, a study was to reveal double the number of cases of presenile dementia in a group of 2 600 painters in and around Copenhagen than in an equivalent group of workers in the same region not exposed to solvents (Mikkelsen, 1980). In the late 1980s, Danish official estimates put the number of workers thought to be brain-damaged by solvents in the thousands. Most of the victims complained of impotence and had had relational problems or were divorced. Solvent-induced psychoorganic syndrome (POS) is now an identified and recognized occupational illness, not only in the Nordic countries but also in the Netherlands, Belgium, Germany and Switzerland. Depending on the stage to which it has progressed, POS leads to personality disorders (irritability, impulsiveness, anger, depression), impaired concentration, memory, comprehension and sexual dysfunction.

The consensus among specialists is that all solvents have narcotic effects and hence consequences for the central nervous system[24]. But the dose of one must be higher than the dose of the other to have these effects. Toluene is frequently cited in cases of POS (Viaene, 1996-1997).

A series of studies reported an increased risk of spontaneous abortions and birth defects (cleft lip/palate, cardiovascular system and central nervous system defects) in children of mothers exposed to solvents, including toluene and xylenes (Pagès, 1999). Paternal exposure was also found to pose a number of risks to the unborn child. A review of the literature published between 1966 and 2003 concluded that paternal exposure to solvents leads to an increase in congenital central nervous

[22] Disulfure de carbone, fiche toxicologique n° 12, INRS. (Carbon disulfide, toxicology data sheet No. 12, INRS, France.)

[23] Measured or calculated in relation to a reference period of eight hours time-weighted average.

[24] The main solvents used include aromatic (benzene, toluene, xylene), aliphatic (heptane, hexane) or cyclic (cyclopentane, cyclohexane) hydrocarbons, and halogenated hydrocarbons (trichloroethylene, tetrachloroethylene, chloroform).

system defects (Logman, 2005). Interpreting the results of various studies is made difficult by changes in the solvents to which workers are exposed and multiple exposure. The industrial sectors most concerned by solvent use include the pharmaceutical, footwear and paint industries, laboratories, dry cleaning and the electronics industry. In *Occupational Cancer. The Cinderella Disease*, I recounted the long, hard struggle of British semiconductor industry workers to get recognition of the reproductive and cancer risks they were running (Mengeot, 2007).

Glycol ethers: a big family best avoided

Glycol ethers are a group of organic solvents based on ethylene glycol (the E series) and propylene glycol (the P series). They are miscible with water and fats. They have been widely used in the production of paints, inks, varnishes, adhesives, cosmetics and cleaning products, but also as an organic synthesis intermediate in the chemical industry. The highest exposures have been reported in the paint, silk screening and printed circuit industries. First marketed in the 1930s, they were mainly used from the 1960s onwards as a replacement for what were considered more toxic solvents like toluene and xylene. But their long-term consequences for humans only really started to be assessed in the late 1980s, when animal experiments demonstrated the toxicity of E series glycol ethers on testicular functions and embryos.

A set of consistent findings tends to support the existence of a link in males between occupational exposure to some glycol ethers and infertility as the result of impaired testicular function and sperm quality. The persistence of the effect gives cause for concern. Decreased sperm quality was observed in Paris transport company workshop employees and Paris town hall workers five and seven years after final exposure.

For women, two studies done in the US semiconductor industry showed that glycol ethers used in the industry may increase the risk of spontaneous abortions. Other studies, done in Taiwan in particular, report prolonged menstrual cycles increasing the waiting times to pregnancy. In Mexico, malformations (facial disfigurements, stunted limbs, mental retardation) were described in the children of mothers with a high level of exposure during pregnancy to a mixture of glycol ethers and ethylene glycol. Malformations were also observed in other studies done in Europe and the United States.

Of the thirty-odd glycol ethers in common use, nine are classified as category 2 reprotoxins by the European Union. Their use has been outlawed in cosmetics and consumer products. They are still used in industry, but have been partially replaced by series P products which appear to have no specific toxicity for reproduction. In 2004, the ethylene glycol derivatives regarded as most toxic still accounted for 10% of all glycol ethers used in France. Would it not be a good idea to consider outlawing reprotoxic glycol ethers at European level?

Sources: Les éthers de glycol: un risque méconnu pour la population, *Revue Prescrire* 2007, 27 (288), p. 776-780.

Cordier, S., Multigner, L., Occupational exposure to glycol ethers and ovarian function, *Occupational and Environmental Medicine*, 2005, 62, 507-508.

Cicolella, A., Effets des éthers de glycol sur la reproduction, *Gynécologie obstétrique & fertilité,* 2006, 34, p. 955-963.

The health care sector: when prevention pays

Workers responsible for other people's health (nurses, technicians, doctors) are exposed to a host of reproductive hazards: biological (germs, viruses), physical (ionizing and non-ionizing radiation), chemical (anaesthetic gases, anti-cancer drugs, solvents and disinfectants) and ergonomic (physically strenuous work, long working hours, stress). Many of these have been eliminated through improved working conditions, some can be prevented by improved hygiene or inoculation, but others are unavoidable, so all that can be done is to transfer the worker away from the job as soon as her pregnancy is notified.

Biological risks, especially to pregnant women and their unborn children, abound in the health care sector. Infection may come through bacteria, viruses or parasites transmitted via the respiratory or digestive tracts, skin or blood. Rubella (German measles) is a harmless disease for mothers with potentially tragic consequences for their child (birth defects, spontaneous abortions). Fortunately, there is a vaccine against it as for tetanus or hepatitis A. Not so other infectious agents like cytomegalovirus (CMV) or toxoplasmosis, however. An acquired natural immunity may afford some protection. Without it, or if it cannot be acquired (HIV), and even where rigorous hygiene is enforced, only transferring the worker away offers real safety.

X-rays exacted a heavy toll on medical radiologists, but it took many years to become clear. Almost 50 years after they first came into use, an American doctor showed that radiologists suffered ten times more leukaemias than other doctors. It is to be hoped that radiology and radiotherapy department staff are better protected today. Equipment is better isolated and badges must be worn. Nurses are transferred away from radiotherapy duties immediately they notify their pregnancy, but not so women doctors. Sources of radioactivity also abound in hospitals (cardiac catheterization and radioscopy at the bedside of patients who cannot be moved, for example), which increases the risks. Notwithstanding the precautions taken – lead aprons or screens –, the particularly high-risk period preceding the diagnosis of pregnancy is a continuing concern for hospital sector workers preparing for pregnancy.

Non-ionizing radiation, low frequency electrical fields, microwaves and electromagnetic fields have all come into more frequent use in the past 20 years, but the data with which to determine their risks for reproduction is as yet lacking.

In the 1970s, anaesthetic gases came under suspicion as being implicated in an increase in the number of spontaneous abortions and birth defects among operating theatre staff. The main suspected culprits were halothane and nitrous oxide. Operating theatre atmosphere studies revealed wide variations in the concentration of these chemicals from one hospital to the next (Stevens, 1987). Over time, operating theatres have been equipped with more efficient gas recovery and ventilation systems that have helped significantly reduce the risks. A 1998 survey of 11 small hospitals in southern Italy, however, found an excess of spontaneous abortions among operating theatre nurses. Simultaneous atmosphere measurements revealed nitrous oxide concentrations more than 30 times above the recommended standards (Figà-Talamanca, 2000).

The drugs used to treat tumours are carcinogenic and may, over time, damage the genetic information carried in sperm and eggs. A study done in 17 Finnish hospitals between 1973 and 1980 revealed that nurses exposed to anti-cancer drugs during early pregnancy were at twice the risk of spontaneous abortions (Selevan, 1985). Since these findings were made, special precautions must now taken when preparing and administering anti-cancer drugs, as well as during waste disposal, and pregnant nurses are transferred away from chemotherapy departments. Here again, applying preventive measures has helped decrease adverse reproduction outcomes.

Might other drugs create reproductive risks for those who use them at work? A Danish study of over 4500 pharmacy assistants found an increased risk of spontaneous abortion among individuals exposed to antibiotics (Schaumburg, 1990).

Health care sector jobs are also exposed to ergonomics-related reproductive hazards (stress, long working hours, heavy loads, etc.) mentioned earlier.

Seeing the wood through the trees

The US Senate report on reproductive risks (see p. 23) did not just "name and shame" chemicals that are hazardous to reproduction. It also took issue with the lack of toxicological and epidemiological data for chemicals that were thought to be reprotoxicants but were nevertheless commonly used in medical or industrial applications. It also regretted that US agencies with responsibility for public and occupational health had no data either on the reproductive risks of the chemicals they also regulate, or on occupational exposure limit values. The senatorial report concludes that "the protection against reproductive and developmental toxicity afforded the public by current regulation is uncertain at best". This was considered to be all the more regrettable in view of the steady rise in the working mother population. More than one in two American children are born to a working mother, and 62% of workers of both sexes are of childbearing age, which increases the probability of occupational exposure to reproductive hazards.

The late 1970s saw a wave of labour unrest in the United States focused on reproductive risks (see p. 54). The institutional dynamic may have been inhibited by hostile pressure from industry and government, but the issue still holds a higher place on the agenda than in Europe. After the 1991 senatorial warning, US agencies set to work. In 1996, the National Institute for Occupational Safety and Health – NIOSH – launched an ambitious health and safety at work research programme – the National Occupational Research Agenda (NORA) – involving more than 500 individuals and organizations. The 21 priority research teams set up by NORA included one on fertility and pregnancy abnormalities – the Reproductive Health Research Team, tasked with defining the priority research agenda for preventing and reducing the incidence of reproductive risks. Ten years on, it reviewed the progress to date. Although more than 84 000 chemical compounds are in the workplace, only about 4000 have been evaluated for reproductive toxicity. In their assessment, the researchers drew up a list of "highest priority" chemicals on the basis of two criteria: their toxicity and the number of workers potentially exposed[25].

NIOSH has also done a series of epidemiological studies to evaluate workers' exposure to other chemicals also assigned priority status:

- **Phthalate compounds**: used as plasticizers and solvents in many industrial and consumer goods as different as flexible PVCs, nail polish, perfumes, adhesives and paints. In animal studies, several phthalate compounds demonstrated adverse reproductive effects, especially in

[25] The highest priority chemicals are dibutyl phthalate, boric acid, tricresyl phosphate, N,N-dimethylformamide. Also high/medium ranked are acrylamide,N-hydroxymethylacrylamide, 4-chloronitrobenzene, 2-butoxyethanol, oxalic acid, bisphenol A, and ethylene glycol. Monographs on several of these are available on: http://cerhr.niehs.nih.gov.

males. There are virtually no published data available on workers' exposure to these compounds, although thousands are exposed to them.

- **1-bromopropane**: a solvent and degreaser that is proposed to replace ozone-depleting chemicals in electronics and metal industries. Exposure to 1-bromopropane can occur by inhalation or skin contact during metal degreasing, precision cleaning or the use of bromopropane-containing adhesives. Studies on rats found evidence of reproductive toxicity in both males and females. There are no human reproductive studies.
- **Acrylamide**: it is used in the production of polymers and gels found in a wide variety of consumer products and as a cement binder. There are concerns about current exposure levels.
- **Boron**: it is ubiquitous in nature and found in many consumer products. Limited epidemiological data indicate that boric acid and borax can be reprotoxic in humans. Effects on sperm development have been observed in animals. An American-Chinese study is under way among 1400 workers (Lawson, 2006).

The US researchers believe that two new fields of investigation have emerged since the workgroup was set up in 1996 which require increased vigilance:

- **Nanoparticles**: the potential hazards of the increasing use of these new materials are unknown quantities. Many research programmes are being run on their use in electronic components, cosmetics, textiles, drugs and medical imaging. Some of these engineered nanomaterial products are already being marketed and are widely available. Titanium dioxide or zinc oxide nanoparticles are already currently incorporated in sunblock lotions, for example. The workers who produce them and consumers, including pregnant women, who use them do not know what health consequences the introduction of these microscopic particles into the human body will have. It has been suggested that nanoparticles can cross cell membranes and circulate in the blood. Theoretically, therefore, they could enter the brain and cross the placental barrier.
- **Multiple exposures**: if workers are exposed to multiple compounds or mixtures[26] which act by the same mechanism, effects may be additive or synergistic, even though no single exposure occurs above occupational exposure limits. This theory is supported by toxicological studies on exposed workers showing additivity of adverse reproductive effects from mixtures. The US specialists believe that a mixture formula needs to be used to calculate a lower acceptable occupational exposure level when workers are exposed to multiple chemicals in the workplace.

[26] Mixtures of solvents, fungicides, chlorinated hydrocarbons, or metals.

3. Community legislation: moving jobs preferred over eliminating risks

Reproduction is the only human activity for which there is a biologically-determined gender division of labour. Pregnancy, childbirth and breast-feeding are exclusively women's preserve.

This biological fact that characterizes all mammals has often been used to naturalize labour relations, both as regards reproduction in the broad sense and production. There is no "natural" reason why women should do the lion's share of childcare or housework. Just as there is no "natural" reason for segregating women into specific occupations, activities or sectors.

There is a paradox about occupational health. Reproductive health has been one of the main forces behind getting health and safety at work policies into existence. But these policies have largely failed. Worse, they have added to discrimination against women.

From the dawn of the industrial revolution, exploitation of women workers raised concerns about the reproduction of humankind, concerns which were heightened by the appalling conditions in which children worked, endangering their physical and intellectual development. More than the health and well-being of women as such, it was their biological and socially constructed role in the reproduction of the species that prompted governments to act. The work of women and children had to be regulated to avoid species decline. The first International Labour Conference, instigated by Switzerland, was held in 1890. The invitation letter sent out by the Swiss Federal Council reflected the reasons generally given to justify legislating on work hazards: "Humanity, and the concern to improve the armed force of States, undermined by the decline of many classes of the population, means that things cannot be left as they are."

Legislation has long assigned women and children a specific status as protected groups. For women, this has largely derived from the perception of woman as an anomaly, a set of exceptions to the male norm. Legal regulation and the medical approach of the first century of the industrial revolution are very close on this point. The idea of woman as anomaly has not completely gone from the prevailing rules. It is to be seen in a minor way in references to a "particularly susceptible" or vulnerable group, for example.

Looking at how prevention policies have developed, the dominant trend has for long clearly been a purported protection of health by exclusion. Improving working conditions so as to be compatible with reproduction would have required a political will to set limits on the employers' power to organize production. Rather than eliminate risk factors at source, the standard option has been to exclude women from different sectors or activities. To some extent, the preventive transfer of pregnant women perpetuates this tradition whenever the risks from which women are being removed could actually have been eliminated from the organization of production.

An incoherent and ineffective jumble

The analysis of Community legislation here is focused on chemical hazards. Other reproductive hazards are not addressed or merely touched on but not detailed. Clearly, that does not mean that they can safely be ignored. An attempt will be made to look at them in later publications.

Where reproductive risks are concerned, Community laws have been built up in successive layers, some marked by very traditional approaches. This process has produced a jumble of inconsistent and largely ineffective rules that are one of weakest features of EU health and safety at work law. More concerning still is that, where reproductive hazards are concerned, the market does not work to give any real incentive to a prevention policy. Also, public health policy approaches to reproductive health largely disregard the impact of working conditions.

The first thing is to distinguish the legislation that regulates the marketing of chemicals from that which ensures health and safety at the workplace. The former is all about the free movement of goods and is meant to result in full harmonization of existing provisions in the different Community countries. The latter is made up of minimum harmonization directives that allow Member States to maintain or introduce rules that guarantee better protection for workers.

Market regulation

Regulation of the chemicals market has been a gradual process started by a first Community directive dating from 1967[27]. It has had little effect on reproductive hazards.

The regulations were brought in mainly to enable the chemical industry to move its production around within the Community market. Health and environmental protection requirements were minor considerations, and the entire system relied heavily on producers voluntarily evaluating the risks of what they placed on the market.

The regulation was also developed one layer at a time. It became highly complicated, but very patchy. When Austria, Finland and Sweden joined the European Union in 1995, they were quick to voice their reservations about rules that often provided a level of health protection lower than their own national legislation. In November 1998, the European Commission published a highly critical assessment of the operation of the rules in force[28].

[27] Council Directive 67/548/EEC of 27 June 1967 on the approximation of laws, regulations and administrative provisions relating to the classification, packaging and labelling of dangerous substances, *OJ*, No. L 196 of 16 August 1967.

[28] See http://ec.europa.eu/environment/chemicals/pdf/report-4-instruments_en.pdf.

Where reproductive hazards are concerned, one thing the evaluation notes is that a number of "new effects" are not taken into account by the regulation itself, specifically citing effects on the immune and endocrine systems, central nervous system development and reproduction. The report also looks at how the regulations are being applied, and observes that manufacturers are not reporting new substances marketed by them as dangerous, even though they can reasonably be suspected to be intrinsically dangerous. It notes that surveys done in certain sectors reveal misclassification in 25% of cases and mislabelling in 40% of cases.

Glycol ethers stand as a dramatic and practical illustration of the gaps that remain in the regulations.

Most chemicals that are toxic for reproduction are not recognized as reprotoxins. There is a yawning divide between the scant data findable in the scientific literature and the classification of substances in Community legislation.

There are three reasons for this gap:

1. Most chemicals were never tested for their potential impact on reproductive health. This is particularly true for almost all the 100 000-plus substances and preparations placed on the market before September 1981 which still make up the bulk of chemical industry production. "New" chemicals – i.e., those placed on the market after September 1981 – have been somewhat more systematically evaluated by the producers, but there are only about 4500 of these. And even for these, the tests for reproductive hazards only have limited relevance. According to France's National Research and Safety Institute (INRS), no reproductive toxicity data are available for 95% of chemicals coming onto the French market;
2. A minority of substances have been tested, but chemical industry tests were not necessarily up to par and above all, yielded results that did not necessarily result in correct classification. Treatment of the results may have resulted in reprotoxins being placed on the market unaccompanied by appropriate information for users;
3. Independent evaluation by public authorities was done only in isolated cases, meaning that full evaluations were done only of a few dozen substances.

- Aggravating circumstances

Comparing the situation of reprotoxins with that of carcinogens, a number of common points emerge. The obstacles relating specifically to reproductive hazards are more significant, however.

The common points are inappropriate classification in some cases that denies or underestimates the risks, the lack of a systematic Community policy on substitution of these chemicals, and deeply flawed evaluations by the public authorities.

The additional obstacles regarding reproductive risks are:

1. There is an international agency for carcinogens – the International Agency for Research on Cancer (IARC) – that provides independent,

quality expertise. Classification of substances by the IARC to some extent makes up for the deficiencies of Community legislation (Sandret, 2005)[29]. The lack of a recognized authoritative international centre for reprotoxins makes evaluation of the EU classification much more difficult. An examination of different lists, however, does reveal many instances of misclassification;

2. "Reproductive hazard" is a concept that covers a much wider range of potential human health effects that are harder to analyze than for carcinogens. Health damage may take place over one or more generations, and may take very different forms. The few registers kept on such diseases tend to contain little detailed information on parental occupations or exposure to work-related reproductive hazards. That is a major obstacle to identifying risk factors;
3. The EU legislation that introduces measures to protect workers from carcinogens at work is more detailed and coherent than that on reproductive hazards. It puts some pressure on the market that may lead to significantly reduced use of some carcinogens, including those still authorized by Community legislation. Asbestos use, for example, was in sharp decline even before any marketing ban came in. The same thing is found to a much more limited extent for reprotoxins, although it has happened in specific cases like glycol ethers as a result of labour action.

[29] For example, the number of French workers exposed to carcinogens is doubled when substances classed as carcinogens by the IARC are added to the EU list.

Lists that help fill the gaps

The EU classification of substances that are hazardous to reproduction is not sufficient to identify all the risk factors related to chemicals use. Even taking category 3 mutagens or reprotoxins into account leaves big gaps. These can usefully be filled by referring to different lists compiled by scientific organizations.

- Demeter is a small list of some sixty substances compiled by France's INRS, available on CD-ROM from www.inrs.fr/htm/demeter.html.
- The US National Toxicology Program's (NTP) Centre for the Evaluation of Risks to Human Reproduction has a website containing detailed information on a number of substances http://cerhr.niehs.nih.gov.
- In 2007, the French Agency for Environmental and Occupational Health Safety (AFSSET) compiled a list of 445 chemicals that are potentially hazardous to reproduction, 50 of which it classified as priority substances. Its report is available on the AFSSET website www.afsset.fr.
- The European Commission drew up a list of 553 substances in 2000 thought to be endocrine disrupters:http://ec.europa.eu/environment/endocrine.
- For neurotoxicants, researchers have compiled an initial list of 201 chemicals whose neurological effects are documented in the scientific literature. They consider that a thousand substances may cause neurotoxic effects as indicated by laboratory tests, and argue that the five recognized developmental neurotoxicants probably represent only the tip of the iceberg. Listed in Grandjean, P., Landrigan PJ, Developmental neurotoxicity of industrial chemicals, *The Lancet*, 16 December 2006, p. 2167-2178. www.thelancet.com.

- **Classification, labelling and risk phrases**

A number of substances have been classified as mutagenic or toxic for reproduction. There is no special classification for endocrine disrupters (see p. 11). Some may be included in other categories of hazardous chemicals. Also, risk phrase R64 "May cause harm to breastfed babies" is not linked to a specific classification.

Reproductive toxicity includes impairment of male and female reproductive functions or capacity and the induction of non-inheritable harmful effects on the progeny. Effects on male or female fertility, includes adverse effects on libido, sexual behaviour, any aspect of spermatogenesis or oogenesis, or on hormonal activity or physiological response which would interfere with the capacity to fertilise, fertilisation itself or the development of the fertilised ovum up to and including implantation. Classification into category 1 is done on the basis of human epidemiology studies. Classification into category 2 or 3 is done on the basis of data from animal experimentation.

Preparations that are carcinogenic, mutagenic or toxic to reproduction are classified and labelled in the same category as the substance they contain, if their carcinogen, mutagen or reprotoxin content is equal to or greater than:

- 0.1% for category 1 and 2 carcinogens or mutagens;
- 1% for category 3 carcinogens or mutagens;
- 0.5% for category 1 and 2 reprotoxins (0.2% for gaseous preparations);
- 5% for category 3 reprotoxins (1% for gaseous preparations).

Categories of classified dangerous substances and risk phrases associated with that classification

Mutagenic substances

- Category 1: substances known to be mutagenic to man (R46)
- Category 2: substances which should be regarded as if they are mutagenic to man (R46)
- Category 3: substances which cause concern for man owing to possible mutagenic effects (R68)

Substances toxic to reproduction

- Category 1 (R60 and/or R61):
  - substances known to impair fertility in humans;
  - substances known to cause developmental toxicity in humans.
- Category 2 (R60 and/or R61):
  - substances which should be regarded as if they impair fertility in humans;
  - substances which should be regarded as if they cause developmental toxicity to humans.
- Category 3 (R62 and/or R63):
  - substances which cause concern for human fertility;
  - substances which cause concern to humans owing to possible developmental toxic effects.

The classification requires users to be informed about certain characteristics of the substance. This can take different forms: labelling and a safety data sheet. The label must include a pictogram which is a symbol indicating the danger, risk phrases (R phrases) and safety advice (S phrases).

Labelling of mutagens and reprotoxins

Categories	Pictograms	Indications with R phrases to be used
1 or 2	 T-Toxic	Mutagenic substances R46: May cause heritable genetic damage Substances toxic to reproduction R60: May impair fertility R61: May cause harm to the unborn child
3	 Xn-Harmful	Mutagenic substances R68: Possible risk of irreversible effects Substances toxic to reproduction R62: Possible risk of impaired fertility R63: Possible risk of harm to the unborn child

The labelling rules and risk phrases will be changed before long by the introduction of a globally harmonized system. A proposal for a Regulation was drawn up by the European Commission in June 2007.

The new system, promoted by the United Nations, provides for:
- harmonized criteria for classifying substances and mixtures by the nature of the physical, health or environmental hazard;
- harmonized hazard communication elements, including requirements for pictograms, labels and safety data sheets (SDS).

It is due to come into operation sometime in 2008. There will be a transitional period during which substances and preparations marketed in the European Union will be double-labelled (Musu, 2007).

- Pictograms, categories and risk phrases in the GHS

The Health Hazard pictogram with the signal word Danger will replace the indication of danger term Toxic and the GHS hazard statement will replace the risk phrase e.g. R60.

It will be assigned to:
- respiratory sensitizers, category 1;
- mutagens, carcinogens and Reprotoxins (CMRs), categories 1A and 1B;
- specific target organ toxicity (single and repeated exposure), category 1;
- aspiration hazards, category 1.

The same Health Hazard pictogram with the signal word Warning will be assigned to:

- CMRs, category 2;
- specific target organ toxicity (single and repeated exposure), category 2;
- aspiration hazards, category 2.

EU Label	GHS Label
	
Toxic	Danger
May impair fertility	May damage fertility or the unborn child

- **A classification that seriously underrates the risks**

There is a wide gap between what is known and classification on the basis of the European regulations. The Demeter database compiled in France by the INRS contains datasheets on some sixty chemicals. We reviewed those on the CD-ROM put out in September 2006 which document the effects on reproduction of the substances studied as reported in the available scientific literature. Two-thirds of the substances were not classified in the European Union (41 datasheets). Thirteen were classified as category 2 reprotoxins and five as category 3 reprotoxins. A proposed classification was under review for 1 substance. Looking at the scientific literature summarized by the datasheets, it is clear that the reason for non-classification in some cases is lack of data, while in other cases, there is a clear policy issue. The scientific literature documents what in some cases are significant effects for various substances.

For example, the EU documentation on the classification of acetone cites a NIOSH study on mice which reports a marked decrease in the number of females producing viable broods. And yet no classification was made. Ethanol also escaped classification notwithstanding studies going back to 1973 that identify significant effects on men's and women's reproductive health.

Classification is often hindered by industry pressures. The difference between the language of scientific literature and that of policymaking is another obstacle. Scientific papers use turns of phrase that emphasize uncertainty and caution. They seldom come to an unqualified conclusion that a causal link exists between exposures and medical conditions, and stress the inevitable limitations of any research (Gee, 2008 ; Grandjean, 2008). Often, policy makers do not apply the precautionary principle and mistake necessary scientific caution for a lack of evidence to justify a given measure. For example, the first article reporting testicular disease in animal tests on a glycol ether from the ethylene series was published in 1979, but it was not classified as toxic to reproduction in the European Union until 2003 – a quarter of a century's delay in which workers were exposed and their health put at serious risk.

Number of substances classified as mutagenic and toxic to reproduction in the European Union

	Categories 1 and 2	Category 3	Total
Mutagenic	176	77	253
Toxic to reproduction: impairs fertility	29	74	103
Toxic to reproduction: developmental risk to the unborn child	72	40	112

Table based on INRS data and updated by Tony Musu of the ETUI-REHS in March 2008

Not one substance has been classified as a category 1 mutagen, but 176 – mostly oil by-products – have been classified as category 2 mutagens. Approximately 180 substances have been classified as toxic to reproduction. Only 19 are classified as category 1, and 13 of these are lead and lead derivatives. Neither mercury nor 1,3 butadiene are included.

All carcinogens should be regarded as hazardous to reproduction. A growing body of research indicates that exposure to such chemicals may cause some types of cancer in the children of exposed individuals. It is not just foetal exposure that is relevant; both maternal and paternal exposures need to be taken into account.

What REACH adds

REACH was adopted at the end of 2006[30]. It is a major reform of chemicals production and marketing in the European Union. The fundamentals of REACH were set out in a Commission White Paper in 2001. Between the White Paper and the final regulation, all-out lobbying by the world chemical industry watered down some of the most far-reaching and innovative aspects of the reform. The final text is a compromise. Nevertheless, it is still an undeniable improvement over the previous regulation. REACH is now being implemented. We are in a transitional period that will run until 2018 in which the chemical industry will have to register approximately 30 000 substances. The criterion is the producer's annual production volume: all chemicals produced in quantities of one tonne or more a year will have to be registered. If they are not registered, they can no longer be placed on the market. The rule is, "no data, no market".

A technical dossier containing certain information must be submitted with the registration. What the dossier must contain varies with the production volume. A risk assessment for all uses of the chemical is required only for production volumes of 10 tonnes a year and more. The higher the annual production, the more comprehensive the information will be, as the tests required vary with the tonnage. Chemicals of the highest concern will be subject to an authorization procedure. The European Commission may authorize some of these chemicals under certain conditions. Measures may also be taken to restrict use or marketing.

How well REACH works depends on several things:

1. How effective the new Helsinki-based European Chemicals Agency (ECHA) is. Will it be properly resourced and independent from the chemical industry? Will it put health and environmental protection before business profits in every case?;
2. Systematic co-operation between Community and national authorities.

[30] This is not the place for a point-by-point analysis of REACH. Readers are referred to the other publications listed in the bibliography for that.

This is vital and cuts across many spheres of activity: market controls; drawing up lists of priority substances for authorization procedures; State monitoring of authorization procedures (the criteria are quite vaguely worded and will need to be interpreted); feedback on health and environmental problems with the use of chemicals, giving more weight to chemical hazards in national prevention strategies, etc.;

3. A driving force for change in society and especially in workplaces so as to keep up pressure for an effective prevention policy. Experience teaches that any regulation, however ambitious, will have only limited effect without this. Trade unions and environmental protection groups will have a crucial role to play;
4. Public agencies developing an independent toxicological expertise. The chemical industry will be drawing up tens of thousands of registration dossiers for chemicals. On past record, it is crucial for the public authorities to be able to check the data and not simply rubber-stamp the procedures carried out in private laboratories.

Independent toxicological expertise is vital

The tests to register chemicals under REACH will be done by the producers themselves or laboratories contracted by them. Some of the tests required are specified by the Organisation for Economic Co-operation and Development (OECD), within which industry exerts a significant influence. That shows how important it is for chemicals of the highest concern to be evaluated by public bodies with good quality, independent toxicological expertise. The case of bisphenol A (see p. 22) exemplifies the bias that may affect industry or industry-financed toxicological expertise. Researchers analyzed the 115 animal studies published up to December 2004: 94 reported significant effects. Some studies claimed no observed effect at exposures of up to 50 µg/kg/day, but doubt is cast on such a level by 31 studies. The scientific uncertainty is more easily understood by asking the question, "Who paid for the research?". More than 90% of publicly-funded studies reported observable adverse effects, while 100% of the industry-financed studies found the opposite! One factor behind this result is the rat varieties chosen for the tests.

Sources: Hughes, C., vom Saal, F., An extensive new literature concerning low-dose effects of bisphenol A shows the need for a new risk assessment, *Environmental Health Perspectives*, 2005, vol. 113, No. 8, p. 926-933.

Hansson, S.O., Rudén, C., Wandall, B., Bias in toxicology, *Archives for Toxicology*, 2007, vol. 81, p. 605-617.

• REACH and reproductive risks

As yet, the potential impact of REACH can only be guessed at. The new regulation has its strengths, but also some weaknesses, so here, we shall simply point to what REACH has introduced that is positive, and note a number of failings and obstacles. How REACH will play out is not foretold in the text of the regulation. It will be shaped by social and political dynamics. Implementation of the reform is certain to meet with fierce resistance from the chemical industry. It would be naive to believe that the regulation will automatically bring improvements. How REACH interacts with preventive practices in workplaces will be one decisive factor in determining what impact the reform finally has. If reproductive hazards are made a priority of workplace safety, then REACH implementation will likely be informed by worker pressure and a feedback of information that will deliver significant improvements. Without that input, the results could be much more disappointing.

- Registration

There will be an obligation to register for approximately 30 000 substances. There are two grounds for being excluded from the scope of REACH:

1. Production volume: all chemicals produced in quantities of less than one tonne a year per producer (or importer, for chemicals produced outside the European Union) are excluded;
2. Specific exceptions mainly for substances falling within the scope of other regulations. Where reproductive hazards are concerned, specific attention should be paid to four of these exceptions: intermediates, i.e., manufactured substances subsequently synthesized into other products; plant protection products and biocides; medicinal products for human and veterinary use, and waste. The exemptions are partial for the first three categories, but total for waste. A recent survey done by the INRS in France indicates that substances that are hazardous to reproduction are frequently found in industrial waste (Cholot, 2007).

Registration does not automatically improve prevention. What effect it will have depends on the evaluation of authorized substances. How much information is supplied will depend very much on how much of the chemical is produced. The evaluation information will be public, and will be able to be consulted on the Helsinki Agency's website.

Put simply – the quality of the information will be largely dictated by the quantity of production, and that is calculated in volume per producer per year.

The potential for improving reproductive health protection is very limited for chemicals produced in the one to ten tonnes range. There are three situations:

1. Most of the chemicals already on the market before REACH enters into force are what is known as phase-in substances for which the producer need only supply information on the physicochemical properties. No specific test is required;
2. This provision is qualified to the extent that some tests are still required for phase-in substances that can be predicted as likely to meet the criteria for classification as harmful to health and the environment. The problem is that if substances are not correctly classified in one of the "of concern" categories, a vicious circle is likely to be created. If they are not tested, any under-assessment of the risks will not be corrected;
3. For non-phase-in substances (chiefly those produced and put on the market after REACH entered into force), the same tests are required as for existing substances that can be predicted as being harmful. Only gene mutation must be tested for by an in vitro study on bacteria. If it proves positive, additional studies must be carried out. No specific test is provided for reproductive toxicity. No chemical safety report is required.

From 10 tonnes upwards, things improve. All chemicals are subject to the same requirements, whether or not notified under the previous regulations. A chemical safety report is required. A number of tests are required to assess if they are toxic for reproduction or mutagenic. The number of tests requires depends on two things: production volume and the exceptions provided for. The tests provided for quantities between 1 and 100 tonnes are in theory compulsory (unless the chemical falls within one of the exceptions). From 100 tonnes upwards, the producer must propose the additional tests to be done and a timetable for doing them. The European Chemicals Agency will take the final decision. The tests specified generally refer to OECD guidelines.

The fact that registration is done by the producer (or importer) raises clear issues of consistency between registrations of the same substance by two or more different registrants. REACH provides that a classification and labelling register will be kept to avoid having different information on the health impacts of the same substance. The same system also applies to substances and preparations produced in quantities of less than one tonne a year if they meet the criteria for classification as a dangerous substance.

- Evaluation

All evaluations are done by the European Chemicals Agency, with the collaboration of the Member States for the evaluation of substances as such.

Evaluation covers three things:

1. Mandatory evaluation of the proposed tests. There are two reasons for this: to limit animal testing and to ensure that the information required is relevant;
2. Optional evaluation of dossiers. This is for quality control of registration dossiers;
3. Evaluation of the substance as such. This is key to the reliability of the system established. The first two types of evaluation are on dossiers. This affords a means of checking the information supplied by the producer. Not all substances will be evaluated. Only some will be subject to evaluation under a three-year Community programme, as determined by a list of priority criteria set by the Agency. This process will need to be kept under close review to see that it works better than the evaluation by public authorities provided for under the pre-REACH regulations.

It is too soon to say whether all this will be enough to bring a positive resolution to the conflict of interest created by the decision to leave the initial evaluation to the producers of the substance. Much of the reform's credibility depends on the development of worker and public oversight of the quality and probity of the registration procedures and the tests carried out for them.

- Authorization

Authorization is a key component of REACH implementation. How effective the reform is will largely depend on an innovation policy being implemented to replace substances of the highest concern in every case.

Unfortunately, the authorization criteria as finally worded in REACH are not crystal clear. The principle that substances of the highest concern should be replaced with a safer alternative whenever there is one was not included.

Substances subject to authorization will be included on a list (Annex XIV of REACH).

Substances that may be listed as reproductive hazards are:

1. Substances that meet the criteria for classification as category 1 and 2 carcinogens, mutagens or reprotoxins (CMR);
2. Substances of equivalent concern for which there is scientific evidence that they may cause serious damage to human health or the environment. REACH expressly puts endocrine disrupters in this category.

Inclusion on the list of substances subject to authorization therefore depends on two things: proper risk assessment, and a policy decision which will be largely shaped by the Commission and Member States. A public consultation procedure has been provided for. The European Chemicals Agency will have to give public notice on its website that a dossier has been drawn up with a view to listing a substance. This makes it vital for the trade unions to work with one another and with other advocacy groups, like public health and environmental protection groups, to keep these procedures under the closest review.

Listing a substance triggers the authorization procedure. The final decision lies with the Commission. The authorization criteria laid down by REACH are very unclear. Both for substances that meet the CMR criterion and those of equivalent concern, a distinction has to be made between those for which the chemical safety report indicates a level below which there is no risk to human health (what REACH calls the DNEL or "derived no-effect level") from those for which there is no DNEL. DNELs are formulated by the producers according to specific use exposure scenarios.

Where a DNEL has been defined, authorization will be granted if the risk is regarded as adequately controlled, regardless of the intrinsic hazard that the substance represents, and even if there is a safer alternative.

If no DNEL could be defined, stricter conditions apply. Authorization will be granted only if it is shown that the socioeconomic benefits outweigh the risk to human health or the environment of using the substance, and if there are no suitable alternative substances or technologies.

Independently of the authorization procedures, REACH allows for a Community measure to be adopted restricting the marketing of substances. Such measures are directly in line with the 1976 Directive on restrictions on the marketing and use of certain dangerous substances and preparations. The different substances concerned by these measures are listed in Annex XVII of REACH.

- The role of user firms

The pre-REACH regulations did not provide for the feedback of experiences from chemicals-using firms to enable chemicals producers to take account of the health impact on workers in actual conditions of use.

REACH establishes organized co-operation between downstream users and producers (or importers) and intermediaries all along the supply chain. More on this can be found in the Department's other publications on REACH.

This co-operation makes it especially important to have a proper risk assessment done in all firms where chemicals are used.

Further reading

- *The REACH Book. The full REACH Regulation No 1907/2006 as published in the OJ*, ETUI-REHS, 2008. Full version of the text published in an easy-to-carry softback format with annexes (barring annex XVII) and Directive 2006/121/EC on the classification, packaging and labelling of dangerous substances.
- Pickvance, S. *et al., The impact of REACH on occupational health with a focus on skin and respiratory diseases*, Sheffield university, co-publication ETUC/ETUI, 2005, 76 p.
- REACHing the workplace. Trade unions call for a more ambitious European policy on chemicals, *HESA Newsletter,* Special issue, No. 28, October 2005.
- Musu, T., *REACHing the workplace. How workers stand to benefit from the new European policy on chemical agents*, ETUI-REHS, 2004, 36 p.

Prevention at the workplace

Community legislation on guarding against reproductive hazards at workplaces is full of holes. There is no across-the-board organized approach, simply specific rules for pregnant and breastfeeding workers, and a handful of general rules scattered through other directives (1989 Framework Directive, 1998 Chemicals Directive, different Ionizing Radiation Directives, Biological Agents Directive, etc.).

This is damaging to both equality and health protection. Women's access to employment is not properly guaranteed: reluctance to make preventive arrangements against reproductive hazards may tempt an employer not to hire women for certain jobs. In some countries, it is still unlawful to expose women to certain risks. The Community directives perpetuate situations where women face the invidious choice of protecting their unborn child, or suffering what may be a substantial loss of income. Also, the specific rules on maternity protection are ineffective and not consistent with the order of priority of preventive measures. Waiting until the eighth or tenth week of embryo development to eliminate a hazardous exposure is not a coherent preventive solution.

• A smattering of general provisions

No Community health and safety at work directive deals comprehensively with reproductive hazards. They are addressed in a series of general, unspecific and non-detailed provisions, which makes them difficult to enforce in practice for many reasons. Foremost among the general provisions is the 1989 Framework Directive, which requires employers to develop a prevention policy in line with certain priorities: avoiding risks wherever technically possible, evaluating risks that cannot be avoided, giving collective protective measures priority over individual protective measures, etc.

Other directives address specific risks. The Ionizing Radiation Directives do not consistently reflect the Framework Directive's order of priority of preventive measures; instead, they put the main focus on controlling the individual dose of radiation to which a worker has been subjected. This often results in a "dose selection" which has no connection with effective prevention. Other directives deal with broader categories of risk (chemicals, biological agents) but contain no specific provisions on reproductive hazards. They are not designated as being of particular concern and, where chemical hazards are concerned, the odd exposure limits found in Community legislation do not provide an appropriate level of protection against reproductive hazards.

There are also the deeply flawed Working Time Directive, which contains a few provisions on night work, and the Manual Handling of Loads Directive.

There is a marked contrast between the far more coherent and detailed provisions of the Carcinogens Directive[31] and the vague and imprecise way the directives just mentioned address reproductive hazards. The Carcinogens Directive was extended to mutagens in 1999. In 2002, the Commission announced its intention to extend the scope to reprotoxins – a change which would reflect existing legislation in several Community countries and considerably clarify matters. In relation to REACH implementation, it would be apt to give greater prominence to chemical reproductive hazards in health and safety at the workplace.

Extending the scope of the Carcinogens Directive would be an important first step towards a more systematic protection against reproductive hazards by clearly defining the priorities for it: substitution, work in a closed system where substitution is technically impossible, collective preventive measures, implementing health surveillance including after exposure and employment are at an end.

• A restricted scope

Domestic and self-employed workers are outside the scope of the Community health and safety at work directives. It is a fact that more than 90% of paid domestic workers are women. The proportion of self-employment varies widely between Member States. It is widespread in some sectors or occupations highly exposed to reproductive hazards like health care, farming and construction. It is outrageous that domestic workers have no right to maternity leave under Community law.

• And exposure limits?

In the early 1980s, the European Union set about defining binding occupational exposure limit values for the main chemical and physical risk factors. It faced numerous hurdles. Directives had to be adopted unanimously, and each Member State had a right of veto. The British government, often supported by the German government, wielded its veto extensively to impose exposure limits that were insufficient to protect health. Procedural delays and political obstacles meant that between 1980 and 1988, exposure limits were defined only for lead, noise and asbestos. The process was abandoned after a failed attempt to set an exposure limit for benzene.

[31] Directive 90/394/EC on the protection of workers from the risks related to exposure to carcinogens at work. It was codified by Directive 2004/37 of 29 April 2004.

Since 1988, exposure limits can be established at Community level in two different ways:

1. Indicative exposure limits are established in lists laid down by Commission directives. Two lists have been adopted so far. A third is in the works, but some exposure limits have been challenged by the employers;
2. Binding exposure limits are adopted mainly under the Carcinogens Directive. The proposals take account of the economic impact and often result in compromises that do not guarantee a satisfactory level of health protection.

The only binding exposure limits adopted in relation to reproductive hazards are for lead. These concern exposure limits for air concentrations, and a biological limit value for concentration in the blood (blood-lead level). They were put up as a provisional compromise in 1982, and have never been revised. They provide no real health protection, either as regards reproductive health, or against other health damage from exposure to lead. In 2002, the Scientific Committee for Occupational Exposure Limits proposed other values. The Commission has so far taken no steps to improve the situation.

To avoid discrimination and give effective health protection to men, women and their offspring, exposure limits must take account of reproductive hazards and the unavoidable fact that pregnant women will be exposed, if only during early pregnancy. This means that exposure limits must be calculated to allow an appropriate safety margin. Such limit values will also help towards a more effective solution: the search for alternatives to using substances that are hazardous to reproduction.

The EU Member States currently operate widely differing exposure limits. Levels of protection are very unequal and the quantity of substances covered by an exposure limit also varies. There is a real need for Community harmonization to avoid health-damaging competition.

Some countries operate different exposure limits for men and women in some cases. This can produce employment discrimination. Germany's Commission for setting exposure limits (the MAK Commission) publishes specific values for pregnancy.

It defines four groups according to the teratogenic potential of the substance:

- group A: the risk has been unequivocally demonstrated. Exposure during pregnancy entails a risk to the unborn child even if MAK (maximum concentrations at the workplace) or BAT (biological tolerance values at the workplace) values are observed;
- group B: according to currently available information damage to the embryo or foetus must be expected even when MAK and BAT values are observed;
- group C: there is no reason to fear damage to the embryo or foetus when MAK and BAT values are observed;
- group D: the currently available data are not sufficient for classification.

Finland takes a rule-of-thumb approach to defining exposure limits for pregnant workers by dividing existing occupational exposure limit values by ten.

The Pregnant Workers Directive: ineffective and potentially discriminatory

The Directive of 19 October 1992 on protection for pregnant workers and workers who have recently given birth or are breastfeeding is particularly unsatisfactory. It has produced patchy prevention. The directive falls into three groups of rules. It contains provisions intended to avoid employment discrimination against pregnant and breastfeeding women. It prescribes a minimum 14 weeks' maternity leave split into a compulsory period of two weeks and a voluntary period of 12 weeks. It lays down a number of preventive measures. Only this latter aspect of the directive will be looked at.

Risk assessment plays a central role in the directive, which does not prescribe any specific preventive measures but simply gives a non-exhaustive list of risk factors and requires them to be taken into account when planning preventive measures. A series of risk factors are listed in two annexes to the directive. In 2000, the Commission published more detailed guidelines, but as this was done after the deadline for transposing the directive into national law had expired it had only a marginal influence on the provisions adopted in the Member States. Its legal status is very uncertain.

There are four big problems as regards joined-up preventive measures under the directive:

1. Does an employer have to wait until a woman notifies her pregnancy, or must he assess the risks beforehand and eliminate or reduce them before any worker notifies her pregnancy? We would argue the latter, but the directive is very unclear on this. A risk assessment performed after the worker has notified her pregnancy does not make for an effective prevention policy. In most cases when the employer is notified of the pregnancy, it is too late to prevent all the risks. The available data show that pregnancy is generally notified to the employer between the 7th and 10th weeks. The greatest risks of foetal malformation lie between the 3rd and 8th week of gestation with different peak periods for different organs. Likewise, there is a bigger risk of miscarriage during the first weeks of pregnancy, which means that measures to prevent exposure to mutagens or reprotoxins will be ineffective for the great majority of women.
2. The directive requires employers to adopt preventive measures on the basis of the risk assessment. The priority is to eliminate the risk and prevent it at source. Failing that, the employer must make temporary adjustments. If that is not technically or objectively feasible, the employer must move her to another job. If it is not technically or objectively feasible to move the worker to another job, she must be given leave from work for the period necessary to protect her health. The directive offers no criterion for assessing what is not objectively feasible. Is financial profit motive enough for not taking what would

be costly measures? Practice suggests so. The most common option where risks are high is preventive transfer to another job. This turns pregnancy into an illness requiring removal from the workplace. The failure to guarantee sufficient pay means that financial pressures may force some women workers to keep doing hazardous work.

3. The directive contains an article 6, entitled "cases in which exposure is prohibited". In fact, this article does not prohibit employers from exposing pregnant and breastfeeding workers to hazards, simply from obliging such workers to be exposed to them. This puts the final decision on the worker, who may be swayed by financial or other pressures. Such a provision runs counter to the basic principles of prevention. If an exposure is hazardous and to be avoided, removal away from it cannot be made a matter of purely individual choice.
4. Unlike the other health and safety at work directives, the 1992 Pregnant Workers Directive does not provide for workers' representative bodies to be consulted on preventive measures. That adds to the tendency to treat protection for pregnant workers as provision for individuals in an abnormal situation rather than an issue of collective health and safety in every workplace.

No business case for reproductive health

The legislative framework for preventing reproductive hazards in workplaces is not fit for purpose. There is nothing new about this conclusion, which is shared by many players. What are the stalled issues?

There is systematic obstruction from employers over reproductive hazards. The Commission proposal to extend the scope of the Carcinogens Directive to reprotoxins met with opposition from the European employers' association, BusinessEurope. Attempts to develop both binding and indicative Community exposure limits take place in a strained atmosphere fuelled by a virulent employers' campaign which is backed by many governments and sometimes even finds a receptive ear in the European Commission. Adoption of the third European list of indicative exposure limits, for example, was held up by challenges to several proposed exposure limits by the European employers. Two of these were for potential reproductive toxicants mentioned earlier: mercury and carbon disulfide.

For employers who set great store by preventive measures that are profitable for business in cost-benefit terms, reproductive hazards do not merit special attention. Reduced fertility, miscarriages, birth defects and the future health problems of children of exposed workers do not normally put a cost on business. The link between working conditions and these forms of health damage largely escapes notice. Generally-speaking, none of these health impacts gets recognized as an occupational disease, and suing for compensation is a very uncertain business.

More broadly, what the employers mainly want after the adoption of REACH is a rest from legislation, or even a scrapping of some of the regulations on prevention of chemical hazards in workplaces. But it is clear that REACH alone will not resolve the problems of prevention. At best, it will create a positive momentum which itself will also depend on a tightening-up and more systematic enforcement of the regulations on chemical hazards at work.

The directive was adopted in 1992 as a provisional compromise. The Commission should have put forward a draft amendment in October 1997. It did not. In July 2000, the European Parliament gave a critical assessment of the directive's implementation and voted for a revision to

improve it. It reiterated its demand in January 2008. In March 2008, the Commission put a revised proposal for a Directive to the European social partners. The proposed amendments relate exclusively to maternity leave. Regrettably, the Commission has passed over in silence the very necessary improvements required to the directive on maternity and health protection of pregnant workers at work.

The most effective preventive approach would be to concentrate the rules on maternity protection into conditions specific to the situation of pregnant women[32] and adopt a much stricter policy on prevention of chemical hazards. Priority must go to eliminating and replacing substances that are hazardous to both female and male reproduction and, wherever elimination is not technically feasible, effective control measures should be adopted to prevent or minimize exposures. This is why preventive measures against reproductive hazards must be organized along the same lines as those laid down in the Carcinogens Directive, and the specific provisions on pregnant women should be a safety net to be kept so that whenever reproductive hazards were not eliminated, specific measures throughout pregnancy would be justified. By contrast, there is no good case for the general prohibitions on exposure of women that remain in force in some countries. But these prohibitions should not be lifted if that will reduce the level of health protection. The real need is to promote a reorganization of production that will protect the health of women, men and their offspring.

[32] Chiefly in the areas of ergonomics, working time and work intensity, and increased protection against particular infectious agents and ionizing radiation.

4. Better prevention of work-related reproductive hazards

"Roxane is 12 years old. She neither speaks nor walks. She stares vacantly at things and people. Her prominent chin seems to take up all her bony face. [...] Between 1987 and 2000, her mother, Claire worked in a silk-screen printing workshop in the suburbs of Pau (Pyrénées-Atlantiques). *I would clean the frames used to apply the inks*, she explains. *I didn't have any special protection. It was ordinary cleaning work*. Preventive measures in this 17-employee small business are minimal. There is not even hot water laid on for hand-washing, even though ethers easily pass through the skin barrier [...] When Claire fell pregnant at the end of 1991, she went to the occupational health doctor for her industry. She was concerned about the effects that chemical fumes might have on her unborn child. The doctor told her a few precautions to take and wrote to the employer suggesting she be moved to a less exposed job. Some hopes. On 17 August 1992, Roxane was born severely disabled[33]."

"Thierry Garofalo has been unfit for work since 1997. At the age of 48, he suffers from impaired vision, anaemia, intoxication-caused muscle tissue changes and reproductive dysfunctions. He believes the problems all date from 1988-1993 when he was working on electronics components in a clean room at IBM where coveralls, gloves and other forms of protection had to be worn, and the tables were cleaned several times a day with cleaning products containing glycol ethers[34]."

How many Roxanes and Thierrys are there? The number cannot even be guessed at. The failings in prevention are such that no systematic records are kept of people exposed to reproductive hazards at work. Any effects these exposures may have are revealed only in exceptional cases when victims fight back or through trade union action. The one certainty is that these cases are not randomly distributed throughout the population, but concentrated in certain sectors and occupations. Working in certain branches of the chemical industry, the cleaning industry or the health care sector increases the likelihood of exposure to chemicals that are hazardous to reproduction. Social inequalities in health can also strike the generations unborn. Using mutagens at work can alter germplasm and cause diseases. Nurture becomes nature.

Only exceptionally do such situations leave the private sphere and assume a collective dimension. The information campaigns run by

[33] Ethers de glycol. Des solvants en procès, *L'Express*, 7 March 2005.

[34] Les éthers de glycol sur le banc des accusés, Novethic.fr, 12 November 2003.

voluntary groups in France and the United States helped alert public opinion to the dangers posed by glycol ethers. In Sicily, concerted action by the population of Gela, a town that is home to a vast petrochemical complex, led to a large-scale survey being carried out[35]. This revealed that 520 of the 13 060 live births between 1992 and 2002 were affected by birth defects. This is double the Italian average. There is a particularly high incidence of some defects, like hypospadia, an abnormality in the opening of the urethra. Children born with six fingers or toes, only one ear or hydrocephalus were also reported. There are no data on miscarriages. The prevalence of cancers in the survey population is four times the Italian average. There are two reasons for this tragedy. At the height of operations, up to 12 000 workers were employed on the site unprotected by elementary preventive measures against the long-term risks. The firms in the complex discharged a cocktail of hazardous waste into the environment. 44 000 tonnes of carcinogenic petroleum-derived oils were found beneath the plant. Some exposures came from eating local fish poisoned by dangerous chemicals discharged into the sea. Cadmium was also found in tomatoes grown nearby the factories.

The trade unions believe it is essential to break the vicious circle of failings in prevention that seriously impair knowledge production, resulting in widespread neglect by research leading to underestimation of the risks, which gives grounds for inadequate prevention. But union action can change this situation. A recent study reported that, "Experience has shown that the most potent occupational reproductive hazard was reported by the workforce rather than detected by occupational health screening" (Winker, 2006). Widespread grassroots action in the United States in the 1970s helped to put a public spotlight on work-related reproductive hazards and prompted improvements in prevention. The adoption of REACH arguably creates a real opportunity for progress in this area.

The United States: trade unions and feminist groups join forces for direct action

Trade union and feminist group thinking around reproductive health issues began to converge from the latter half of the 1970s in the United States. It was a time in which women had managed to clear away most of the legal hurdles that stopped them from working in particular branches of US industry. Female labour force participation in traditional male strongholds was measurably growing. A number of big firms introduced a foetal protection policy to exclude fertile women from a number of jobs involving exposure to substances like lead, mercury, benzene, vinyl chloride, etc. This included chemical industry giants like Monsanto, American Cyanamid, Allied Chemical, Goodrich, Union Carbide and Olin, but also firms in other sectors, like motor manufacturing, General Motors in particular.

These foetal protection policies served two main purposes:

- to avoid having to take effective collective preventive measures;
- to preclude claims for damages as a result of reproductive health damage.

[35] Gela Malata, *La nuova ecologia*, 12 December 2006, p. 16-19.

The discriminatory effects of these policies are clear. Employers justify them by the stereotype that women work only for pin money, and that their first duty is to ensure generation replacement. No such policy operates in traditionally female sectors where reproductive hazards are high (agriculture, textiles).

The forced sterilization of five women workers at the American Cyanamid factory in Willow Island (West Virginia) sparked widespread protests in 1979. Feminist groups, labour unions and civil liberties defence groups formed the Coalition for the Reproductive Rights of Workers (CRROW) under the rallying cry, "No more Willow Islands". The Federal occupational safety and health agency (OSHA) fined the company for insufficient protection against different chemical hazards. Backed by the chemical industry, the company went to court and eventually won its case. The trial court judgement on foetal protection policy upheld the employers' practices.

OSHA's response was to draw up joint guidelines with other government agencies[36] to enforce the twin aims of protecting reproductive health and eliminating discriminations against women. These draft guidelines addressed most of CRROW's demands by forcing industry to evaluate the reproductive hazards of the substances it produces. They were opposed by the chemical industry which claimed that they would undermine industry competitiveness and cost it US$ 1.4 billion. All the industry giants – Exxon, Monsanto, Dupont, Union Carbide, Shell – and their associations campaigned against the guidelines.

The advent of Ronald Reagan as President of the United States in 1981 ushered in a climate much more hostile to equality and workers' health. Reagan had declared in his electoral campaign that there was no need for OSHA. OSHA's Director, Eula Bingham, a reputed scientist independent of industry, was replaced by a construction industry executive, Thorne Auchter, a move of which the AFL-CIO trade union confederation said, "They tried to kill OSHA". The new director was quick to destroy OSHA booklets on lung diseases which he saw as anti-business. In this new political context, the guidelines were not adopted and OSHA's activity on reproductive hazards tailed off.

In a bid to halt the reversal, the labour unions returned to the legal fray. Eventually, their doggedness paid off. In March 1991, the Supreme Court found for the unions and feminists in a ruling on a case brought by the United Auto Workers (UAW) union against Johnson Controls, the US' biggest car battery manufacturer. Its foetal protection policy introduced in 1982 faced 275 women workers employed in 14 factories across the country with a stark choice: undergo sterilization and keep a fairly well-paid skilled job, or refuse sterilization and have to accept lower-paid work.

Faced with the threat of transfer to another job and a pay cut, Gloyce Qualls, a 34 year old worker with high personal debts had little choice but to agree to tubal ligation. Another worker, 50 year-old divorcee Virginia Green, refused sterilization because of the health risks this kind of surgery represented at her age. She had to leave her job of 11 years and take a deep pay cut. The struggle by Johnson Controls workers

[36] The Equal Employment Opportunities Commission (EEOC) and the Office of Federal Contract Compliance Programs (OFCCP).

was instrumental in the formation of a coalition of trade union, feminist, and public health defender activists.

A decisive role in the action was played by the Coalition of Labour Union Women, which was the driving force behind an alliance of trade unions and the feminist movement. The alliance's central demand was prevention of reproductive risks for women and men alike. An article published at the time notes that, "That situation has changed. The issue of reproductive hazards is now a top priority for many union safety and health departments. The United Steelworkers of America, for example, is putting a great deal of effort into specific cases in the lead and chemical industries in both the United States and Canada. The International Chemical Workers (ICWU) devoted a major part of their last international convention to this issue and unanimously adopted a strong and detailed policy statement. The Oil, Chemical and Atomic Workers (OCAW) have begun to distribute a questionnaire on reproductive hazards to their membership. All of the organizations are working hard on individual cases" (Wright, 1979).

This grassroots action also prompted the research community and institutional players to put a bigger focus on reproductive hazards.

An obstacle course

As pointed out in the previous chapter, the current Community legislative framework is far from satisfactory when it comes to protecting workers' reproductive health, and national legislation in most EU countries has seldom plugged the loopholes. Some positive breakthroughs can be reported: some countries have already legislated to widen the scope of the rules on carcinogens to include reprotoxins. Quite detailed information on reprotoxins is available in some countries.

The gaps in the regulatory framework cannot be an excuse for union inaction. Even with all their limitations, the existing rules can give leverage to more systematic action. This section sets out to explore this potential and suggest some elements of a trade union action plan.

A good place to start is by raising awareness within the trade union of the importance of action for reproductive health. It is an issue that gets overlooked for various reasons:

- it is only very exceptionally addressed in prevention policies and there is a lack of information available;
- reproductive health involves sexual activity and the most private areas of people's lives. It is in many ways a taboo subject, which makes collective debate difficult. Male infertility is particularly difficult to talk about. Health policies favour technical responses – the different forms of assisted reproduction – over prevention;
- the labour movement is swayed by the misguided belief that reproductive health is exclusively a woman's affair, especially pregnant women. That is not conducive to a critical assessment of existing practices on maternity protection;
- the visibility of problems is completely fragmented and individualized. A child born with a birth defect, repeated miscarriages, a young child

dying of leukaemia are horrific tragedies, but seldom is the link made with working conditions. They seem to be wholly a matter of individuals' private lives.

Women's continuing struggle for sexual and reproductive health

Sexual and reproductive health is beset by many obstacles in our society. The trade union fight to rid workplaces of reproductive hazards forms part of a broader struggle. The labour movement did not grow up free of embedded gender assumptions. Women in many countries were excluded from trade unions for quite lengthy periods. One section of the labour movement wanted women excluded from some or all forms of employment. Women's labour action never sought such exclusion, however, but fought generally to improve working conditions and promote equality at work. It reflected an awareness that participation in paid employment could become a means of liberating women from the traditional roles to which they were consigned.

Women's action for sexual and reproductive health has tended to be primarily focused on a woman's right to have control over her own body, which means being able to break the link between sexual activity and reproduction. From the late 19th century, minority fringes of the labour movement, sometimes in loose alliance with the early feminist organizations, claimed such things as access to sex education and contraception, decriminalization of abortion, the repeal of anti-homosexuality laws, the abolition of discrimination against consensual unions and children born out of wedlock.

Even today, inequality persists in the different countries of the EU. Women's rights remain constrained by restrictive, and even criminal law, rules. The gains made by previous generations are being called into question in some countries. Criminalisation of abortion is a source of glaring social inequalities. More affluent women can usually procure abortions in hygienic conditions by going abroad or checking into private clinics, whereas a greater number of working class women put their lives at risk by resorting to unsafe methods of termination.

Better prevention of reproductive risks requires a mix of actions on three fronts: workplaces, sectors and society as a whole.

Workers, key actors in prevention

There is no doubt that risk assessment provides one of the best opportunities for launching preventive health initiatives on reproductive hazards. As previously mentioned, Community legislation requires a risk assessment to be done for pregnant and breastfeeding workers. But it does not expressly require workers or their representatives to be consulted. The 1989 Framework Directive, on the other hand, requires a risk assessment that covers all working conditions, and participation by workers and their representatives is an important element of this assessment. These two assessments must be linked and the general risk assessment must include an analysis of reproductive risks if the prevention policy is to be coherent.

This link is expressly provided for in Spanish legislation. Section 25 of the Prevention of Occupational Hazards Act provides that, "the employer shall take into account in the assessments the risk factors that may affect the reproductive function of male and female workers, particularly in cases of exposure to physical, chemical and biological agents that may have mutagenic effects or be toxic for reproduction, both in regard to fertility and child development, with the object of taking the necessary

preventive measures." France's Labour Code is also very specific on this point. Article R 231-56-1 requires an assessment of exposure to mutagens or reprotoxins be done and repeated periodically in particular to take into account advances in knowledge about the products used on any change in the conditions that may affect the exposure of workers. Any new activity involving such agents can be undertaken only after performing the risk assessment and taking appropriate preventive measures.

Up to 400 000 French workers exposed to reprotoxicants

Little is known about European workers' exposure to substances classified as mutagenic or toxic to reproduction. The Sumer survey done in France in 2003 offers some evidence. About 1% of French employees – 186 000 people – are exposed to four substances classed as category 1 and 2 mutagens by the European Union (the only ones identified by the survey): chromium and its derivatives (58% of cases), benzene (25% of cases), acrylamide and ethylene oxide. The heaviest users of mutagens are the metallurgical and metal working, chemicals-rubber-plastic and mechanical engineering industries, plus health care personnel for ethylene oxide.

Approximately 1% of French employees – nearly 180 000 – are also exposed to category 1 and 2 reprotoxins. Production and maintenance workers are most exposed, but research personnel are also concerned. The only products identified by the survey are lead and its derivatives (66% of cases), dimethylformamide, cadmium and its derivatives, affecting workers in industry, business services and the building trades.

Source: *Les expositions aux produits mutagènes et reprotoxiques*, Enquête SUMER, ministère de l'Emploi, de la Cohésion sociale et du Logement, DARES, No. 32., August 2005

While not all other European countries may have such clearly worded legislation, it can readily be argued that the Framework Directive's principles must be consistently applied to reproductive hazards.

In practice, many firms' risk assessments do not cover reproductive hazards. As a result, there is generally no planned prevention of them, and the workers are not informed – still less consulted – about the risks that exist.

Arguably, a first stage in implementing a systematic policy to protect against reproductive hazards is to have the contents of the risk assessment checked by the trade union and workers' reps to determine whether reproductive hazards have been taken into account and whether the preventive measures are effective. In firms where the assessment has not yet been done (or where a new assessment is planned), the workers' reps can put the issue of reproductive hazards on the agenda.

When assessing reproductive risks, it is important to review all the potential physical contributory factors (chemical, physical and biological agents) in such risks.

The work organization in place should also be checked with three things in mind:

- how far the work organization contributes directly to reproductive health problems (night work, for example);
- how much control workers have over their working conditions and what influence they can have on prevention policies;
- whether general company management includes occupational health

considerations (strategic choices on the organization of production or the business, quality of prevention policy, training and information, etc.).

A second means of action is maternity protection policies. Unclear wording in the Community Pregnant And Breastfeeding Workers Directive has resulted in different levels of prevention from one country to the next. In some States, pregnancy-related risks must be assessed before, not after, a worker notifies her pregnancy in order to put preventive measures in place. Elsewhere, the situation is less clear-cut and general practice seems to favour automatically moving pregnant workers away from a certain number of jobs. More effective collective preventive measures are almost never contemplated. Here again, consistency must be demanded.

Reproductive health, the poor relation of risk assessment in Italian hospitals

The workers' safety reps coordinating committee for Piedmont's principal hospitals surveyed the organization of prevention in the sector in 2004. The trade union survey, covering 28 of the 34 hospitals in this region of northern Italy, and some 48 000 hospital staff, was carried out by 76 workers' reps or prevention reps and regarded reproductive hazards as a priority for research and action. It made two findings.

(1) Overall, preventive measures are too patchy and not fit for purpose. In more than 45% of cases, the risk assessment did not take protection of reproductive health into account. In more than 40% of cases, information on organic solvents did not mention risk phrases R60-R64. Less than half the hospitals had procedures for systematically re-assigning pregnant workers transferred away from their jobs to alternative work.

(2) Risk awareness among medical directors, risk assessment, programming of preventive measures and training were all markedly better in hospitals that have regular, systematic consultations with workers' reps. So, 93% of hospitals where workers' reps were consulted had a risk assessment in place versus 50% of other hospitals. Similarly, a close correlation was found between consultation of workers' reps and the existence of reproductive risk assessments – the workers' reps were consulted in 75% of hospitals where there was a reproductive risk assessment, but seldom in hospitals where there was no such assessment (30% of cases). Similarly, there was a link between reproductive risk assessments and co-ordination meetings being held between the different participants in prevention, including the workers' reps.

The survey also highlighted concerns about miscarriages related to working conditions; these were raised by women workers in a third of hospitals. The workers' safety reps confirm that it is an increasingly frequently discussed issue. Women laboratory workers are categorical about the link between their job and this problem. Medical directors, by contrast, downplay this, arguing that the risks are not sufficiently established, and that the number of pregnancies and miscarriages is too small to compile robust statistics. The workers' reps recommend that national registers be set up for health surveillance of the problem, although more sectoral monitoring systems would not be excluded.

Some of the failings and breaches of rules have been cured since the survey, which has given a new impetus to union action for occupational health. But it is no easy task. One trade union official reports that hospitals are much keener to comply with the letter of the law, but that improvements in working conditions are still beset by many obstacles.

Source: *La sicurezza sul lavoro negli ospedali del Piemonte*, Coordinamento dei Rappresentanti dei Lavoratori per Sicurezza, Turin, 2005

The workers' reps should make it a policy to ask the employer what assessment of maternity-related risks has been done, and how far it has resulted in a plan of action that gives priority to eliminating the

risks rather than moving pregnant workers. This clearly does not mean objecting to a transfer whenever that affords better health and safety. A series of studies have observed that preventive transfer reduces the risks of premature birth among women exposed to hazardous occupational conditions (Croteau, 2007). But the priorities need to be clearly set, and elimination of risks put first. Also, if the risk assessment for women reveals the existence of risk factors, it must be checked whether effective preventive measures are planned and implemented to protect the reproductive health of all workers in the workplace.

The issue can be tackled from two different angles, therefore: the general risk assessment and the maternity protection policy. But, when reproductive hazards have been identified, the steps to be taken in the following stage are the same. Prevention then needs to be tackled using the same approach as for carcinogens. The first priority must go to replacing the hazardous substances or processes wherever that is technically feasible. It is also important to keep a register of exposed workers with detailed information on the risk factors and exposure levels. These registers must be retained and lead to health surveillance being put in place that is appropriate to the problems arising from the reproductive hazards. That health surveillance must be continued after the end of exposure.

Preventive transfer is sometimes used in the Netherlands for any worker, male or female, planning to have a child and for whom a risk assessment establishes that reproductive hazards remain despite preventive measures. In such a case, the normal practice is to move the workers concerned to another job in the company three months before the start of the period in which they plan to conceive a child. This type of measure obviously cannot be used instead of more effective preventive measures, like searching for alternatives to substances or work processes that involve reproductive hazards. But it is unquestionably better than simply limiting transfers to pregnant workers.

A sectoral approach is key

When looking at reproductive hazards, big problems arise with knowing what the risk factors are and assessing actual working conditions. Most Community countries have no lists of risk factors. The information yielded by the chemicals market rules is inadequate because many substances have not been properly classified and endocrine disrupters are not classified into a specific category. A sectoral approach could help improve prevention by identifying a certain number of risk factors for similar activities, verifying general working conditions and the corresponding exposures, and defining preventive measures.

Tetrachloroethylene is still in fairly widespread use in the dry cleaning sector, for example. Alternative processes exist and preventive measures can limit exposure to this toxicant in a transitional stage. Plainly, active prevention can only benefit from a common analysis and coordinated action in this sector. A combination of sector- and area-based approaches can be particularly effective because much data on births and child and adolescent health is kept on a postcode basis.

Five things can contribute to a sectoral approach:

1. Networking of sector prevention reps in trade unions;
2. Negotiation of sectoral agreements with the employers, including by setting up sectoral prevention bodies in which the trade unions are involved;
3. Support from preventive services. The problem faced here by a sectoral approach in most EU countries is that external preventive services tend to be private organizations competing to maximise their corporate customer base but not specializing in any particular sector. There are odd exceptions, however: Denmark is one; while in Italy, the northwest Tuscany public prevention services in a number of localities are running an experimental programme compiling records on pregnant workers that contain systematically collected information on work hazards and the parents' identity. The records have been used to create a register which can be linked to the register of births in hospitals within the scheme;
4. An active policy by the public authorities, especially the labour inspectorate, to promote sectoral initiatives against reproductive hazards;
5. Implementation of job-exposure matrices based on registers or surveys to identify sectors with the highest incidences of exposure to reproductive hazards. Monitoring of distribution flows of chemicals would also help identify priority sectors.

Sectoral initiatives on reproductive health could first be promoted in particularly high-risk sectors like the chemical industry, cleaning services, the health care sector, etc.

Evidence from Dutch trade unions shows the value of sector-based action. Between 2004 and 2007, two member federations of the FNV, Holland's biggest trade union confederation, ran a campaign titled "Make your workplace child-friendly" in four sectors or sectoral activities: the chemical industry, the metallurgical industry, the woodworking and furniture industry, and building painters. A survey was first done using a detailed questionnaire, to which 662 workers replied. From this, 253 situations of exposure to more than 200 different substances were identified, yielding data for each exposure on the sector concerned and the occupation of the exposed individuals. It revealed a frightening lack of information: some 30% of respondents knew nothing at all about substances that are hazardous to reproduction, and 6% did not know whether they were exposed. Most concerning of all was the woodworking and furniture industry, where close to 50% of respondents knew nothing about possible reproductive risks.

About 40% of respondents were concerned about risks for reproduction, and this concern was highest among the youngest workers and men. The analysis of preventive measures taken by employers suggests why: they were reported by only 5% of respondents in the woodworking and furniture industry, 10% in the metallurgical industry and 40% in the chemical industry. The most common practice is to move men and women who give notice of wanting to have a child to other jobs. That accounts for approximately 70% of the measures taken, but it does not eliminate the risks. Substitution of the most dangerous substances

accounts for less than 10% of the measures taken. Work in a closed system with no exposure was not implemented in any case. Based on this survey, the trade unions campaigned for prevention plans to be adopted against reproductive hazards. The Dutch Centre for Occupational Diseases has also started collecting information on reproductive risks and has included it in its annual report since 2004[37]. Nothing similar is found in any other EU country! The 2004 report records that 6000 children were born with a birth defect, and that in an estimated 5% of cases, occupational exposure was a major causative factor in the defect. That would represent approximately 300 birth defects a year for 200 000 births. No estimates are given for other reproductive health problems (infertility, miscarriages, child development not related to a birth defect).

Include reproductive risks in national prevention strategies

Workplace and industry initiatives can only be really effective if there is a national policy of action on work-related reproductive hazards, and if that policy is tied into public health and environmental protection policies.

Identification of risk factors is a priority. Toxicological expertise is centrally important where chemicals are concerned. The plain fact is that REACH leaves most of this to the chemical industry, which makes the provision of independent research by public agencies even more essential to check the quality and probity of industry evaluations. Likewise, the public authorities at both Community and national level should speed up the definition of exposure limits to avoid the "quasi-privatization" of this aspect of prevention through industry-set DNELs (see p. 46). The systematic collection of medical data through epidemiological research, the keeping of registers and other machinery for feedback of information such as setting up networks within the health system to detect sentinel events for all risk factors.

A range of initiatives could improve the situation here:

1. There should be a regulatory requirement to keep registers of individuals exposed to reproductive hazards in their work. These registers should be centralized by the public authorities. Individual anonymity should be preserved, but the data from these registers should be able to be linked to public health registers that record miscarriages, birth defects and other adverse reproductive health events;
2. Other useful data – e.g., on infertility, cancers and other childhood diseases some of whose causes may be connected with parental exposure to reproductive hazards – should be systematically collected. A longitudinal follow-up study should be done of pregnancies, births and child and adolescent health to get a more accurate picture of the impact of parental working conditions on reproduction;
3. A few Community countries or regions keep medical registers of births which could be supplemented to include data on parental occupational exposures. Finland has had a medical register of births since 1987[38] and specific registers on birth defects (since 1963), infertility treatments (since 1992), premature births (since 2004), etc.;

[37] The reports are available at www.beroepsziekten.nl.

[38] See www.stakes.fi/EN/tilastot/filedescriptions/medicalbirthregister.htm.

4. Birth cohort studies are currently being conducted in Europe on approximately 300 000 people. Researchers in different countries have called for these different national projects to be better coordinated, and for a European mega-cohort to be formed, covering half a million people in all (Kogevinas, 2004). Research done on this basis would significantly improve what is known about the link between pre-natal exposures – whether pre-fertilization parental exposures, or exposures of pregnant women – and child or adolescent health problems. Such progress can only be achieved if information on maternal and paternal occupational exposures is systematically incorporated in cohorts formed for epidemiological research on child and adolescent health.

Identification of risk factors should lead on to much more systematic prevention policies. It must be pointed out that most of the developments in assisted fertilization are not designed to improve preventive health, but to some extent reflect pressure from drug companies and other players in the health sector to turn reproduction into a profit-earning market. A review of the discussions on this issue goes beyond the scope of this publication. Suffice it to say that a fresh impetus for prevention in employment relations may prompt a critical approach to assisted fertilization policies and the growing trend towards turning the human body into a marketable commodity, not least through the use of surrogate mothers.

It is important to point out that current knowledge would already enable far more ambitious prevention policies to be initiated in the specific sphere of health and safety at work.

Some of these policies could be pursued at EU level. Specifically, it will be important to monitor REACH implementation to see whether the authorization and marketing restriction procedures are speeding up the search for alternatives to the most dangerous substances. The trade unions in each country should ensure that their own national authorities are actively engaged in this process, which requires systematic co-operation between the European authorities – chiefly the European Chemicals Agency – and the counterpart national authorities.

The trade unions could leverage the experience gained in workplaces or industries to work more closely together in running awareness-building campaigns on reproductive hazards and provide both policy and technical support to more systematic prevention.

The international dimension of action against reproductive hazards

A border is an imaginary line that cuts through natural space. A wide gulf separates life expectancy at birth on either side of the border that divides the United States from Mexico. While infant mortality from infectious diseases has declined sharply in the border States of both countries, the general infant mortality rate ranges up to double. Birth defects rank high among the causes of death of young Mexican children. Mexico has one of the highest incidences in the world of neonatal neural tube defects (Ramírez-Espitia, 2003). The neural tube is the embryo's rudimentary central nervous system. At one end, it dilates to form the brain.

The rest of the neural tube becomes the spinal cord. Neural tube defects can have a range of consequences. Some, like anencephaly, result in death; others lead to different degrees of impairment, like spina bifida which is an incomplete closure of the lumbar vertebrae. The prevalence of anencephaly is six times higher in Mexico than in the United States. Babies born with anencephaly are usually deaf and blind. They are born without cerebral hemispheres, and are capable only of rudimentary reflexes. They rarely survive longer than a few days.

One contributory cause of these defects is exposure to toxicants at work and in the environment. Studies point the finger at some organic solvents used in industry, pesticides but also large shipments of toxic waste transported from the United States to landfill sites in northern Mexico. Workers in the *maquiladoras* (assembly plants owned by multinational corporations) along Mexico's border with the United States have taken action to demand preventive measures against chemical hazards.

Employees at the Autotrim car equipment manufacturing plant campaigned repeatedly for better working conditions and freedom of association throughout the 1990s after the women workers became aware of the connection between factory operations and neonatal deaths: "Before, I had really no idea of what was happening in the factory. But a year ago, my second child was born with anencephaly. He died. [...] I thought: what's going on? A fortnight later, another girl was born with anencephaly. In the last year, there have been six cases: two with anencephaly, one with hydrocephalus and three children with breathing difficulties. There have also been more than ten abortions. It was then I started talking to the other women there about what was going on" (Carlsen, 2003).

Global relocations of industrial production over the last two decades has concentrated the unhealthiest activities in countries where workers have the lowest standards of protection. Social inequalities in health, some of which are passed on down the generations, are determined by reproductive hazards. It is in that powerhouse of world manufacturing that is present-day China where the problem probably arises in the starkest terms. The recall of tens of millions of Mattel toys produced with lead paint by the Chinese subcontractors of the world's biggest toymaker was splashed all over the Western media headlines in summer 2007, sparking fears among European consumers for the risks that the toys might pose to western children, but less concern about the health impacts on those at the other end of the chain. The Mattel affair is only the Western slope of a mountain of environmental and health disasters that even the Chinese press can no longer gloss over.

The number of Chinese babies born with defects caused by pollution, later age pregnancies and unhealthy lifestyles is steadily rising, reports the Chinese media. Around a million Chinese babies are born each year with congenital heart disease, cleft palates, limb deformities and other birth defects, the director of the National Centre for Maternity and Infant Health, Li Zhu, told the *China Daily* newspaper. The number is rising, and the incidence rate of birth deformities is now 60 out of every 1000 births, a rate three times that of developed countries, Li said.

Chinese parents, especially urban couples, are choosing to have a child later in life, which increases the risk of birth defects, explains *China Daily*, arguing that "exposure to health hazardous pollutants, and long term unhealthy lifestyles" are also involved. About 30% of babies born with defects die shortly after birth, 30% can be treated, and 40% will suffer lifelong deformities.

The Chinese official press may now be talking about the problem, but it is careful not to mention the social inequalities that characterize reproductive risks. It focuses on what it calls lifestyle choices and environmental pollution. On past record, however, reproductive risks are no more randomly distributed throughout the population in China than elsewhere in the world. They are unequally distributed in a way that reflects social class relationships. 200 million Chinese workers are exposed to toxic chemicals at work according to figures published in 2005 by the Ministry of Health. Exposure to reproductive hazards in industry and agriculture mainly increases the risks for the children of manual workers and peasants.

Children's health pays a high price for cheap batteries

The ETUI-REHS was contacted in 2007 by women workers at the Gold Peak factories in Huizhou in the southernmost Chinese province of Guangdong. The factories make batteries for the Chinese market and for export. Hong Kong-based Gold Peak owns 53% of Gold Peak Batteries International Limited. The women workers who contacted us were suffering from cadmium poisoning and were exposed to other toxicants. They had been repeatedly warned off from talking about the problem by company management and the political authorities.

The workers concerned and an NGO, Globalisation Monitor, carried out a joint survey in three Gold Peak factories in Guangdong Province where the workers were exposed to high levels of cadmium. Of the 1000 workers in the three plants, 126 – 120 women and 6 men – agreed to answer a questionnaire. Many health problems were revealed, including some specifically reproductive health-related disorders:

- 74% of the women reported irregular menstrual cycles;
- 22% of women and two thirds of men reported sexual dysfunctions;
- 13% of the women who had been pregnant had had a miscarriage;
- 46 of the 120 women respondents had given birth while employed by the company.

Some of the questions related to children. Of the 19 children born to a parent who was working in the Huizhou factories:

- 17 had lowered resistance to disease;
- 5 had skin discoloration;
- 14 suffered a range of illnesses from sarcoma to persistent skin allergies, chronic pain, breathing difficulties (frequent flu and colds).

The cadmium batteries produced in China in appalling health conditions are used worldwide in toys and electronic equipment like digital cameras. The International Trade Union Confederation reports that multinationals who use Gold Peak batteries include such names as Canon, Kodak, Nikon, Ricoh, Sony and Toshiba.

Sources: Interviews with Gold Peak women workers (spring 2007); Globalisation Monitor and Gold Peak Batteries Factory Workers, *Investigation into Workers affected by Cadmium*, March 2006; Globalisation Monitor website http://globalmonitor.blogspot.com.

The plight of workers at the Gold Peak factories in the town of Huizhou (see box) is a telling case in point. Their exposure reflects the low priority put on prevention in a process of rapid capital accumulation. The alliance between the Chinese Communist regime and foreign multinationals is based on a development model in which health and safety at

work is seen as expendable. The situation is akin to that of late 19th century Europe, when the ruling classes themselves eventually began to fear that population replacement was being put at risk by unbridled exploitation of whole sections of society.

No prevention policy can be effective unless it also addresses the international dimension of the problem. As with other occupational health issues, it is essential to fight against the double standards practiced by multinational corporations. Throughout the debates on REACH, the chemical industry sought to perpetuate double standards by claiming exemption from the new rules for export products. Trade unions and environmental lobbies in other parts of the world take the opposite tack, trying to use REACH's most innovative aspects to drive chemicals legislation reform in their countries. The Louisville Charter for chemicals that are safer for health and the environment reflects this trend[39]. It has been signed up to by several dozen organizations. There is already a tradition of joint international campaigning in some sectors. The electronics industry is a case in point where action networks have grown up over the past quarter-century. International action against pesticides is another instance, waged in particular by the International Union of Food Workers (IUF) jointly with other organizations like the Pesticide Action Network[40]. The International Industry Federations will also likely have a growing role in the fight for reproductive health.

[39] www.louisvillecharter.org.

[40] www.pan-europe.info.

5. Conclusion

In a previous publication, *Occupational Cancer. The Cinderella Disease* (Mengeot, 2007), we argued that the realization that work-related cancers were not an inevitability, but a controllable risk had been too long coming. What, then, of reproductive risks, which are still going widely disregarded despite the warning-bells that have sounded over the past forty years: the link between foetal irradiation and child leukaemia (1956); the thalidomide tragedy (1961); the Minamata disaster from methylmercury (1968); the discovery that DES causes cancers (1971); the revelation that low dose lead can harm children's nervous systems and impair their intellectual performances (1979), and more? The list has continued to grow, but realization among workers and the general public has not. Certainly, many things hold that growing awareness back, as we saw in the preceding chapter. At this point, we shall consider just one – the complex and challenging relationships between science and work.

In a book published in 2007 (Thébaud-Mony, 2007), the author condemns the frequency with which eminent researchers and specialists put their intellect and knowledge to work for private industrial and financial interests. The industrial sociologist is outraged at employers' demands for often delayed or manipulated epidemiological studies to prove a "statistically significant" risk before taking any preventive measures, arguing that this is a distasteful form of "human trials" when laboratory and animal studies have demonstrated a risk. The most conclusive example is still asbestos, whose ability to cause cancer in animals was known since the 1930s, but which only started to be taken into account in humans 50 years later when it was too late for hundreds of thousands of workers across the world. The signs of impending disaster had been mounting for decades without rousing the scientific community to particular action.

Where reproductive risks are concerned, the situation appears to be mixed. Some scientists have voiced public concerns about the risks posed by chemicals to human reproduction and development. They take issue with the reservations and doubts that are intrinsic to any scientific activity being used to delay decision making and call for a precautionary approach. They argue for a better and earlier link between research and prevention, and that cautionary counsel should prevail even where there is no conclusive evidence.

This new approach is reflected in particular in the work of a spring 2007 conference in the Faroe Islands which brought together Philippe Grandjean, of the Harvard School of Public Health, and 23 other researchers working in the field of reproductive hazards.

At the end of the meeting, these scientists signed a joint statement (Grandjean, 2007) in which they recommend:

- that studies on the aetiology of diseases should take more account of reproduction;
- that chemical exposure assessments should include conception, using umbilical cord blood and breast milk as biomarkers;
- that test protocols to assess reproductive toxicity should be routinely used, and the evidence of them used to lay down safety standards that protect the embryo, foetus and young children as highly vulnerable populations;
- improved communication among the scientific disciplines involved, and between scientists and policy makers.

The 24 signatories of the Faroes Statement argue that three aspects of children's health are important in conjunction with developmental toxicity risks. First, that the mother's chemical body burden will be shared with her foetus or breastfed neonate. Second, that susceptibility to adverse effects is increased during development, from preconception through adolescence. And third, that developmental exposures to toxicants can lead to life-long functional deficits and disease risks.

Another positive factor is the unprecedented opportunity offered by REACH implementation to revisit the rules on chemicals production. But there will be no automatic knock-on improvement. There remain many debates to be had on REACH yet.

Unfortunately, there are also negative signals coming out of the European Commission. Very recent developments suggest that reprotoxins may simply be left out of the revision of the directive on protecting workers from carcinogens and mutagens, even though it was announced in 2002 that the directive's scope was to be extended to reprotoxins. This is the only possible coherent approach to improved health and safety at the workplace, and has long been a key European trade union demand on reproductive risks. It is not just the unions that are concerned. Since 1998, the Council of Ministers has been trying to get a Commission measure on the prevention of reproductive risks in workplaces. There is no denying that, in dropping chemicals that are toxic to European workers' reproduction off the agenda, the Commission is backtracking on its own recommendations.

It remains to be seen whether the European Parliament and Member State governments will accept this Commission U-turn. Whatever the European authorities do, workers and their representatives will have to grasp every opportunity, especially that offered by REACH which covers reprotoxins, to improve prevention and eliminate chemicals and industrial processes that attack the very origins of life. What they assuredly hold most dear – their children's health – hangs in the balance.

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