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Ecology in Brazil

MYTHES AND REALITY

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MINING

Marc J. Dourojeanni
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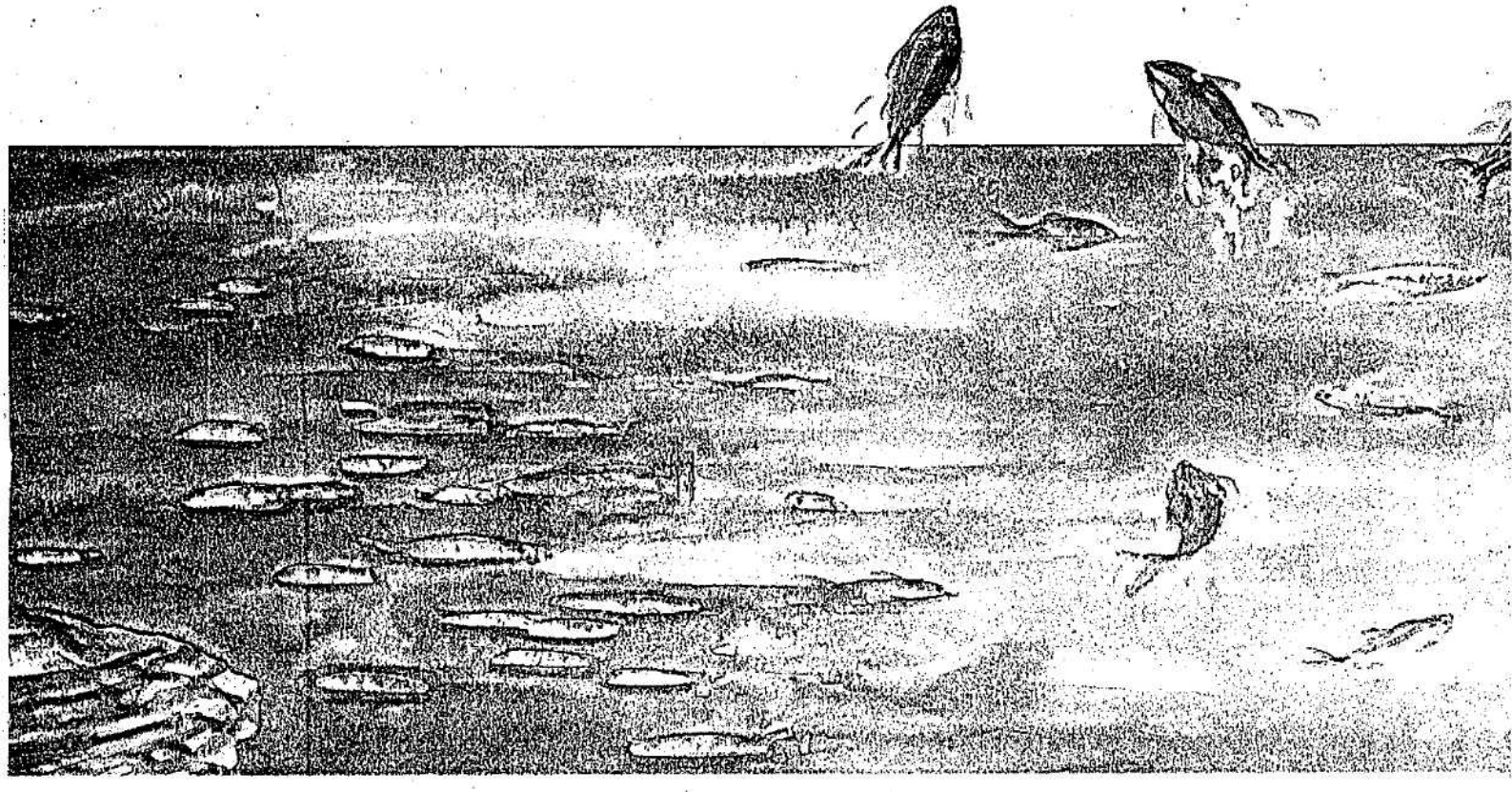

Gold mining has become the most important Amazonian drama of the decade. Surrounded by treasures and illusions, the destiny of more than 4 million people is played out here.

Placer mining of alluvial deposits in the Brazilian Amazon causes a major negative impact on the environment and life style of the people. This impact is second only to the clearing of forests for the purpose of cattle raising and agriculture. Mercury pollution of the rivers is only one of many little known environmental problems created by this activity. Other impacts which are at least as damaging as mercury pollution are the siltation of the rivers and the subsequent effects on fishing and navigation, watershed deterioration, loss of agricultural soils, deforestation, fuel oil pollution and the invasion of Indian reserves and other protected areas. Furthermore, gold production greatly influences the lives of natives and half-breeds in Amazonia, and is presently the greatest obstacle confronted by efforts to establish sustained rural development in the region. Placer mining is also the main factor in the spread of disease, corruption, crime and other problems.

Progress and the environment must necessarily be reconciled with mining, and to this effect, a program which includes the following proposals is presented: ecological zoning, creation of mining reserves, regulation of mining activities, mercury recycling, organization of the miners, social and technical assistance, recovery of affected areas, advising the miners on other economic activities, creation and management of protected areas and taxation of gold production.

Since the first echo of concern was heard for the Amazon wildlife, expansion of the agricultural frontier by means of settlements (planned and unplanned) and cattle raising have been reported to be the greatest threats to the future of this biota (Fearnside, 1980; Hecht, 1986; Buschbaker, 1986). Exploitation of forest products has also been indicated as a cause of deforestation (Browder, 1986 and Dourojeanni, 1990), as well as two other activities: large hydraulic facilities, especially for energy production, and extensive mining operations (Goodland, 1980). Small scale mining operations, known as garimpo in Brazil have only recently come under fire as a serious threat to people and wildlife. Mercury pollution of the rivers (Cousteau & Richard, 1984), the most widely known environmental impact, is cause for special concern. However, this is only the tip of the iceberg which threatens the future of Amazonia. Small scale placer mining causes a series of negative impacts, as this article demonstrates.

The environmental problems of placer mining are discussed on the basis of what little information is available. Most of the data are found in unpublished reports, newspaper articles, personal communications and field observations by the authors. The preliminar conclusions presented here necessarily refer to patterns which must be confirmed by more complete studies,

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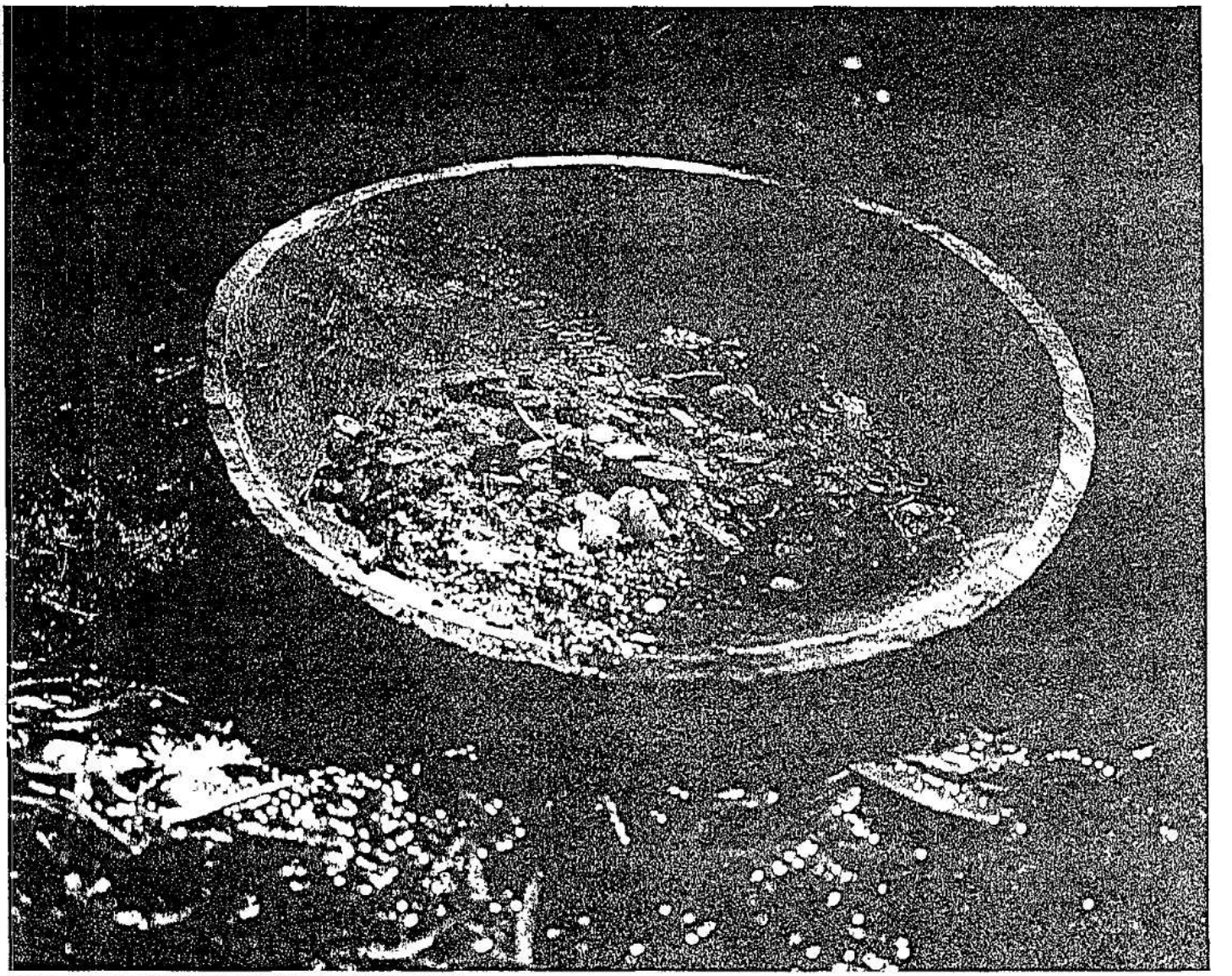

In the past decade, gold mining became solidly entrenched in Amazonia, marked by disarray, it causes as serious an environmental impact as the burning of the forests.

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when available. Still, the problem of placer mining is so important for the future of Amazonia that there is no time to waste.

THE LASTEST GOLD RUSH IN BRAZILIAN AMAZONIA

Amazonia as a Mineral Resources Emporium

Amazonian geology provides for a wealth of mineral resources: bauxite, cassiterite, iron ore, manganese, gold, diamonds, lead, nickel, chromite, beryllium, copper, limestone, phosphate, gypsum and others (Nyrop, 1983, Santos-Bastos, 1984). Iron ore deposits are the largest and richest in the world, and Brazil is one of the world's largest producers of manganese and gold. The mineral wealth of the region is not well-known, especially in environmental circles. Theoretically, there is gold in all corners of Amazonia; estimates produce minimum figures of 3000 tons (Santos-Bastos, 1984). Gold is the most frequently exploited ore, but diamonds and cassiterite are also intensely mined (DNPM, 1986).

Medium sized mining companies often extract cassiterite ore (ex. Jamari, Rondônia), while large companies exploit bauxite and iron ore (ex. Carajás, Pará). Activites in Carajás have created very complex environmental issues (Fearnside, 1989).

From the Eldorado Legend to Gold Mining in Brazil

Prospecting and recovery of mineral resources in Amazonia did not begin yesterday. The Eldorado legend is as old as the European presence on the continent. Prospectors have always been present in Brazilian Amazonia, attracted initially by gold, diamonds and other precious stones, but their numbers have been increasing since the 1800's (Guimarães et al., 1984).

There were several mining booms in the region. During the 60's, there was a rush on cassiterite in Rondônia, which attracted around 50,000 prospectors to the territory, which was practically uninhabited at the time. But the present gold fever has no precedent. It began in the early 1980's as a result of several factors: a) the inviting price of gold on the world market; b) easier access to the Amazon Basin due to new roads, cheaper and safer air transportation, disease control and improved radio com-

munication; c) widespread poverty and unemployment in the rest of the country, caused in part by a profound economic crisis and the foreign debt; d) development of small scale mechanization, especially in gold mining; and e) geopolitical decisions favoring human activities in Amazonia. Some types of prospecting were even directly promoted by federal and state governments, such as in Paraíba and Rio Grande do Norte (Alves, 1984). The Serra Pelada area attracted 80,000 prospectors in the past decade, mainly because of official propaganda (Feijão & Pinto, 1990).

The Economic and Social Spectrum of Mineral Prospecting

No precise information exists on the exact number of persons directly or indirectly involved in placer mining. This is not surprising considering that prospecting on this scale is essentially an illegal activity. The most frequently quoted figures cite between one million (Feijão & Pinto, 1990) and 1.5 million (Barham, 1990) miners scattered throughout the Amazon basin.

Malm et al. (1990) mentions 650,000 miners, but the press usually cites a figure of two million. Placer mining is practiced throughout Brazil, so the higher estimate probably refers to the whole country, not just Amazonia. In 1980, there were an estimated 250,000 miners (Barham, 1990), but Pfeiffer and Lacerda (1988) give a figure of around 100,000 in 1986. The largest numbers are found in the states of Pará, Mato Grosso, Rondônia and Roraima. On the Tapajós River and in Cumaru-Tucuma (Pará), there are estimated to be 220,000 miners, and the government of Mato Grosso reports figures of between 150,000 and 200,000 operating within the state. Around 50,000 are located in the Poconé County area, just outside the area of the Pantanal. Appoximately 100,000 miners are working in Rondônia and the State of Roraima counted 15,000 in January of 1990, mainly in the Yanomani Indian territory (Brooke, 1990). Feijão & Pinto (1990) estimate that there are around 2000 miners scattered over about 160 million hectares in Legal Amazonia. In this area, 25,000 sets of equipment are operating, including grinders, water jets, tractors, trucks, floats and dredges. These authors estimate that there are 1100 landing strips, 750 small planes, 20 helicopters and 10,000 motorized boats and canoes involved in the mining operations. Figure 1 shows the 16 most important gold mining districts in Amazonia; there are at least 20 other areas in the region.

Information on the number of people indirectly involved in or dependent on this activity is even more inaccurate than

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MINING DISTRICTS, NUMBERS OF MINERS AND CLAIMS IN THE BRAZILIAN AMAZON

Mining Districts	State	No. of Claims	No of. Miners
Tapajós	PA	460	140
Cumaru-Tucumã	PA	100	80
Serra Pelada	PA	1	15
Altamira-Xingu	PA	15	15
Gurupi	PA/MA	25	25
Paru/Jari/Tumucumaque	PA/AP	15	10
Amapá	AP	50	30
Oeste Roraima	RR	150	30 - 45[2]
Alto Rio Negro	AM	-	2
Parauri-Sucundurí	PA/AM	40	15
Madeira	RO	2500[3]	50 - 100[2]
Norte de Mato Grosso	MT	60	100-150[2]
Pontes e Lacerda	MT	-	25
Cuiabá - Poconé	MT	40	50
Porto Nacional Tocantins	PA/GO	15	12
Natividade-Dianópolis	GO	80	30
Former mining companies	-	20	120
Others	-	-	150
TOTAL	-	-	899 - 1014

Source: Feijão & Pinto (1990)

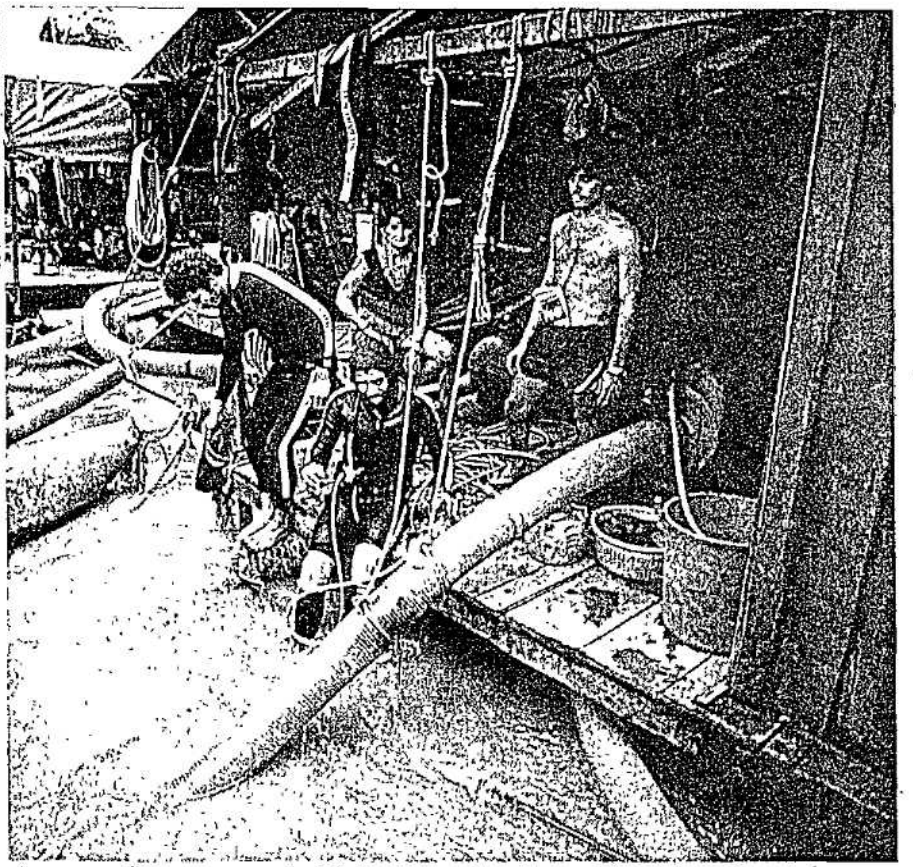
1 AM (Amazonas), AP (Amapá), GO (Goiás), MA (Maranhão), MT (Mato Grosso), PA (Pará), RO (Rondônia), RR (Roraima), TC (Tocantins).

2 The larger numbers came are other source.

3 Dredges and floats

the figures cited above. Persons indirectly associated with placer mining include those who provide basic services such as a) equipment for construction, subsistence and commerce; b) logistic support, mainly fuel and oil, mercury and other chemical products, food and medicine; c) land, water and especially air transportation and e) banking, medical services, prostitution and law enforcement. There is at least a one-to-one ratio between persons directly involved in the mining operations and those involved in support activities. According to Feijão & Pinto (1990), a total of four to five million people (including families) are dependent on placer mining (the majority in Amazonia). This represents about 30% of the population of Legal Amazonia, which is estimated today to be 15 million people.

In 1980, official gold production in Brazil was 13.8 tons, while estimated production was 35 tons, of which 88.07% came from placer mining (Guimarães, 1981). Official production in 1987 was 23.86 tons (IBGE, 1989), which increased in 1989


Ricardo Chaves/Agência Estado

An army of miners, armed with dredges, water jets and floats have invaded Amazonia. In the mining zones, security is at best precarious.

to 48.9 tons (Barbosa, 1990). Unofficial estimates of gold production are much higher. Usagal-Fama (Federation of Unions and Associations from Amazonia) claims that 650 tons of gold were produced in the last decade.

Almost 500 tons, or 100 tons a year, has been recovered since 1985 (Feijão & Pinto, 1990). The 1990 Metals & Minerals Annual Review reports a similar figure of 96.9 tons in Brazil for 1989, the largest gold producer, after South Africa (608.3t), the Soviet Union (300t), the United States (159.it), Australia (197t) and Canadá (158t). Other sources differ considerably from Usagal's estimates however. Estimated gold production for the State of Mato Grosso alone was 100 tons in 1988, of which only 3.8t were officially registered that year. Gold production from the Madeira River in Rondônia is calculated by local authorities to average 90 tons per year. In 1986, with an estimated force of 400,000 miners, the most conservative figures put gold production at 144 tons (Sinal Verde, 1989). Considering estimates from these sources, gold production in Amazonia would be

approximately 300 t per year, which would make Brazil the world's second largest gold producer, together with the Soviet Union. According to the Usagal-Fama estimate, gold production in Legal Amazonia, by state, is as follws: Pará (35%), Mato Grosso (26%), Rondônia (11%), Roraima (10%), Amapá (5%), Amazonas (4%), Tocantins (3%), Maranhão (2%), other states (4%).

Gold mining is the most important economic activity in Amazonia, as well as being a decisive economic factor for the rest of the country. If the above gold production estimate (300t in 1989) is accurate, production that year (300t x US$ 11.00 — 13.00/g) was worth at least 3.3 billion dollars, equal to almost 1% of Brazil' GNP, which benefited only slightly the country's economy because most of this wealth went undeclared. The greater portion was smuggled into other countries, mainly Uruguay, which is today one of the world's largest exporters of gold, although it has one of the smallest lodes.

Mining Techniques

A brief description of the different types of placer mining in Amazonia is given below.

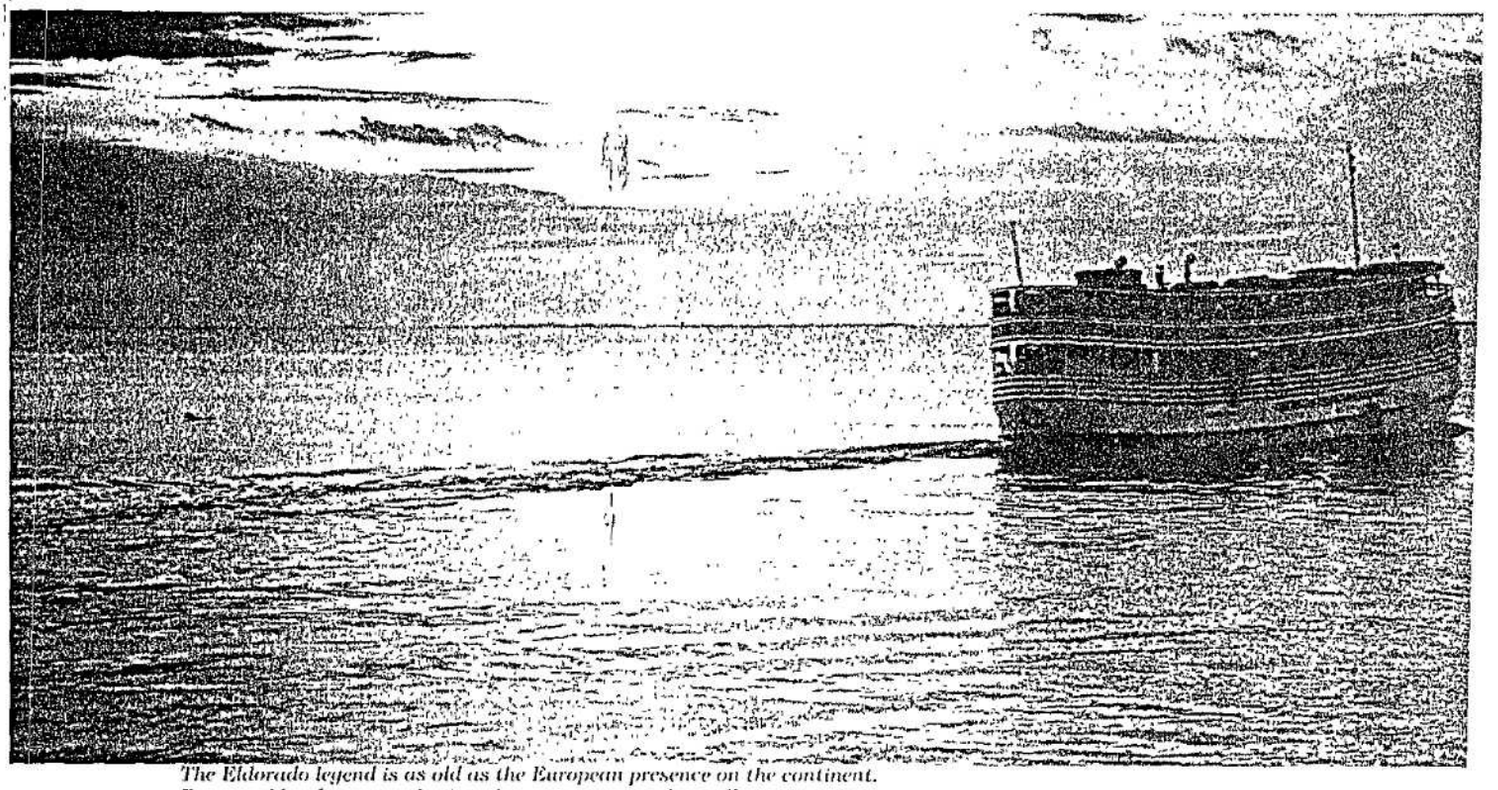
Floats and divers — A widely used technique in large or medium-sized rivers, especially on the Madeira, in Rondônia. A float is equipped with compressed air for diving and a pump to suction sand from the river bed. The diver guides the suction hose to spots in the river bed thought to be richer in gold dust. There were 600 floats operating in northern Mato Grosso in 1989, mainly on the Teles Pires and Juruena Rivers. Thousands of floats work the Madeira River in Rondônia.

Dredges — This technique is replacing the floats and divers. It is already being widely used in large and medium-sized rivers such as the Madeira in Rondônia, the Tapajós in Pará, and the Teles Pires and Juruena in Mato Grosso. The dredges are more expensive, but they are also more efficient. In 1983, there were around 800 dredges in the Madeira River. Today, that number has increased to an estimated 2500, although some local sources cite figures of from 6000 to 7000. This number probably includes floats as well as obsolete equipment.

Trenches and Crushers — Gold is extracted from quartz veins by this technique. It is not common in Amazonia, where gold occurs more frequently in sedimentary deposits, but is widely used in the Pantanal basin. The excavation is taken to the greatest possible depth by tractors, and then deepened manually. The ore is then crushed to free the gold.

Tractors, water jets and crushers — This technique is usually used in gold-rich sedimentary deposits of small rivers or streams. It is widely employed in northern Mato Grosso, causing enormous environmental impact. Huge tractors excavate the river or stream beds as well as the banks, resulting in large quantities of material, which are removed by a hoist to be washed by high-pressured jets of water. It is then concentrated in sluice boxes, or, in some cases, by centrifuge. Another commonly used technique is hydraulic excavation followed by pumping of the sand to the sluice boxes. Large quantities of water are necessary for this technique, and the rivers and streams are often dammed to increase water availability or diverted to facilitate excavation.

Other methods — In most gold mining areas, other types of exploitation are also used. The tailings of mechanized extraction are examined manually. Some miners of modest means still work deposits using portable equipment or panning by hand, as in the past. This type of extraction is the rule in Serra Pelada (Pará), where 15,000 men are working the open pit or prospect-



The Eldorado legend is as old as the European presence on the continent. Pressured by the economic situation, miners come from all over, using any kind of transportation, ready for anything.

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ing in the neighboring areas, using a variety of techniques. Mercury is used in excess here.

Feijão & Pinto (1990) estimate that 47% of the gold is produced by hydraulic methods, which employ 50% of the miners (Figure 2). In the present gold rush in Amazonia, the use of heavily mechanized technology and the subsequent impact on the environment are directly related to this type of extraction method.

DISTRIBUTION OF GOLD PRODUCTION AND NUMBER OF MINERS BY TYPE OF GOLD EXPLOITATION IN BRAZILIAN AMAZONIA

Type of Exploitation	Gold Production (%)	Miners (%)
Hydraulico	47	50
Dredges	19	12
Manual	17	19
Crushers	15	17
Floats	2	2

Source: Feijão & Pinto (1990)

ENVIRONMENTAL IMPACTS

Siltation of the Rivers

The siltation of rivers resulting from all types of mining is probably the most important environmental impact caused by gold exploitation in Amazonia. Considering that the deposits contain 0.5 to 3.5 grams of gold per cubic meter (2 g/m^3 is the average), the production of 100 tons of gold in Mato Grosso implies the translocation of approximately 50 billion cubic meters of sediments yearly in the river basins. Diamond, cassiterite and other mining activities, as well as deforestation, clearing of agricultural lands and overgrazing by livestock also contribute to the sediment load. Finally, these sediments are produced mainly in the dry season, when water volume is diminished, thus making the rivers more turbid.

Increased sediment loads cause several adverse impacts on the river ecosystems: a) increased turbidity of the water, which reduces available light and lowers water temperature, thus affecting the phytoplankton and the entire food chain; as a rule, productivity decreases but some species show increased growth due to nutrient enrichment; b) erratic fish behavior resulting from changes in water quality, which adversely affect reproduction and yearly migration patterns (known as "piracema" in Brazil); c) drastic alteration of river bed topography as a consequence of dredging, float operations, and siltation, thus influencing the habitats necessary for fish reproduction; d) serious threats to navigation, resulting from displacement of the river banks, plus lower life expectancy of reservoirs due to rapid siltation; and e) decreased water quality for energy production and for human consumption.

Mercury Pollution

Mercury pollution is the most extensively documented issue associated with gold exploitation in Amazonia (Boldrini et al., 1983, Lima, 1985, CONSEMA, 1986, Mallar & Benedito, 1986, Pfeiffer & Lacerda, 1988, Lacerda et al., 1988). Mercury is the substance most commonly used to separate gold from other material, after sluicing and/or centrifugation. It is mixed with the concentrated material, producing an amalgam with the gold.

Upon heating, the mercury evaporates, thus freeing the gold. A report from the Mato Grosso State Environmental Agency (FINEP, 1987) states that in 1985, 21.2 tons of mercury were released into the headwaters of the Peixoto de Azevedo River during the recovery of 11.5 tons of gold. This report also indicates that 36.3 tons of mercury were used to produce 41.3 tons of gold in five gold fields in Mato Grosso. Lacerda et al. (1988) estimate

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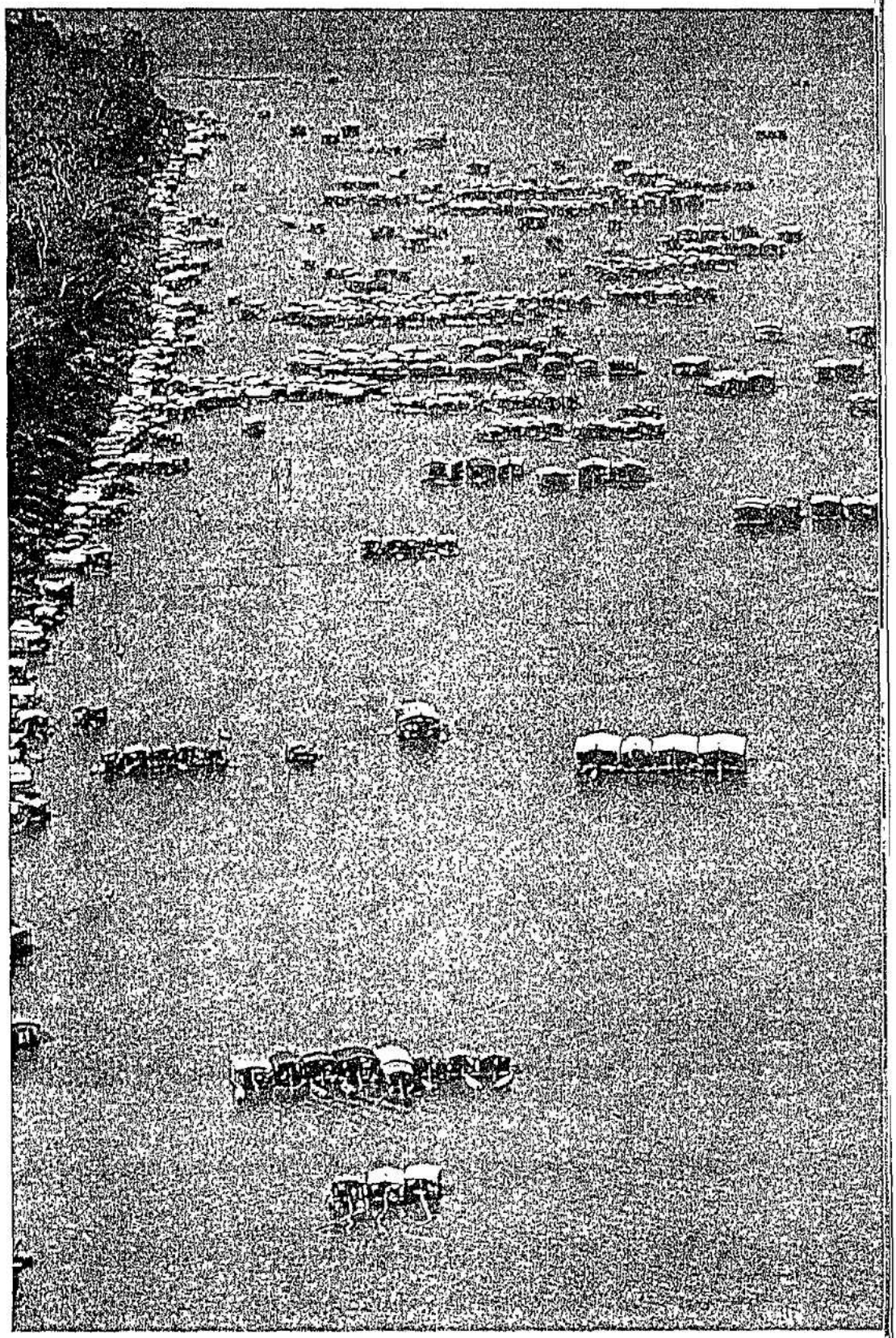

Data from various sources show that 25,000 sets of equipment are serving the placer mines in Amazonia; there are 1100 landing fields and 10,000 motorized boats. (Dredges on the Madeira River).

that 87 tons of mercury were released into the Madeira River from 1979 to 1985. Other sources (CONSEMA, 1986) increase this estimate to 105 tons during this period. Information from different sources on the mercury-gold ratio vary greatly from one region to the next. Pfeiffer & Lacerda (1988) describe the use of mercury amalgamation in gold mining, and estimate that 1.32kg of mercury is lost in the production of 1kg of gold. Of this total, 0.72kg evaporates, while 0.60kg goes directly into the river. The discrepancies recorded among these estimates do not change the fact that large volumes of mercury are entering Amazonia's rivers.

The amalgam is compressed to eliminate the excess mercury, and then heated in two stages. The first stage is carried out right in the mine office (which also serves as bedroom, safe, kitchen and laboratory), with immediate consequences for the miners. This stage frees from 80 to 95% of the mercury, which is discharged directly into the nearest drainage system. The second stage in the heating process takes place in the buyer's office, often within the city, near airport runways or at some other collection point. Here also, no precautions whatsoever are taken, and consequently, the miners are once again on the receiving end. Schools and restaurants located near the gold buying establishments are also victims.

Mercury levels in soils and sediments from the Madeira river in Rondônia are normal for 70% of the samples. In the remaining 30%, levels are high to very high, especially in very fine sediments with increased organic matter (Lacerda et al., 1987). Lacerda et al. (1988) proved that mercury concentration in the tissues of top trophic level fish captured in contaminated areas (especially tributaries) is 10 to 20 times higher than in specimens from pollution-free areas. These levels often surpass the maximum recommended for human consumption (0.5mg/g). The Madeira River itself does not have the physical and chemical properties which favor precipitation of mercury in metal form, and this explains why fish from larger rivers do not yet show high mercury concentrations like those from the tributaries (Malm et al., 1990). These authors confirm the heavy contamination found in streams near mining areas. Measurements reported by Pfeiffer et al. (1988) and Malm et al. (1990) also reveal elevated levels of mercury in fish and human hair, indicating a high degree of exposure by the local population. Therefore, the picture of widespread mercury pollution in the rivers of Amazonia, contaminating the entire food chain, which has man as the final link, is supported by all the available data.

Oil Pollution

Oil pollution associated with placer mining activities also has an adverse impact on the rivers. Used oil from motors,

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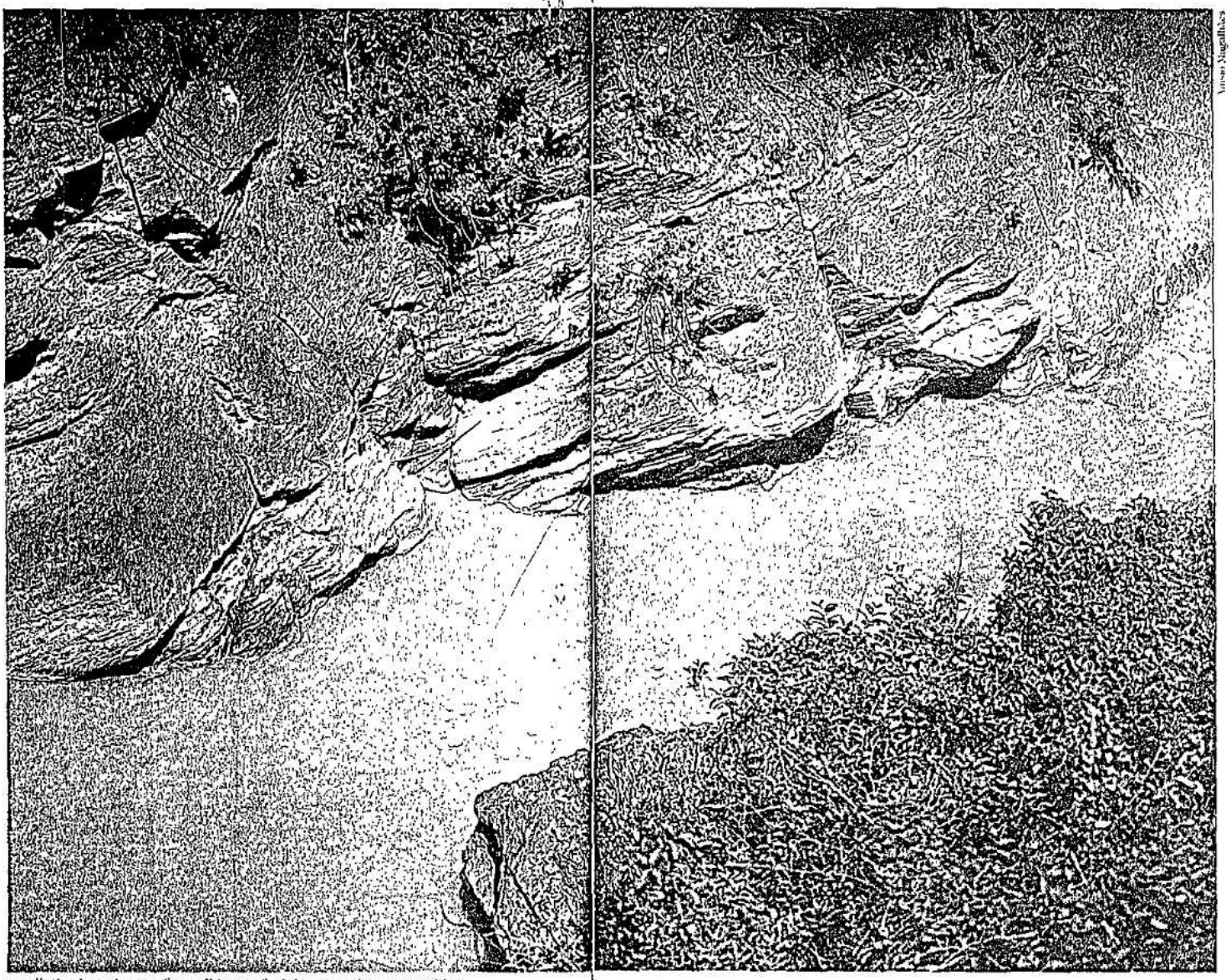

Antonio Magalhães

r pollution by sediments from all types of mining operations is a problem
iany parts of the country, not just in the Amazon.

tractors, trucks, dredges and any other type of equipment is emptied directly or indirectly into the rivers. A 1989 report by SEMARO estimates that the 6000 to 7000 dredges and floats working the Madeira River (Rondônia) discharge five million liters of oil into the river yearly (30 liters of oil every 200 hours (10 working days per motor) totals 90 1/month per boat). The number of tractors, trucks, outboard motors, generators and other motorized equipment operating in Amazonia is not known, but there are at least two motors in operation for every ten miners. Therefore, a minimum of 200,000 motors are operating on the rivers and river banks of the region, not counting those used for other purposes.

Other Types of Pollution

Other chemicals are being used in some gold fields. Large mining companies in southern Mato Grosso and other areas are using sodium cyanide to recover finer gold dust. Detergents are also used. Besides chemical pollution, garbage and organic residues are emptied directly into the rivers or left to rot in empty lots.

Watershed Destruction and Loss of Agricultural Soils

Placer mining is causing other important long term impacts due to the use of tractors, as is happening in the Teles Pires River basin in northern Mato Grosso. The entire river network is being affected by the excavation of each and every stream and small to medium sized river throughout the system. Excavations vary from 4 to 5 meters in depth, and affect both the water course and the river banks, and other alluvial deposits nearby. The best agricultural soils are often partially destroyed because the miners occupy the sites after buying the prospecting rights from the farmers. Farming is abandoned when the miners settle in.

In the Teles Pires River basin, an estimated 50,000 ha were totally destroyed in November 1989, greatly reducing the area of available agricultural lands in a region where good soils are scarce. In aerial view, the Peixoto River basin, an affluent of the Teles Pires, appears to have been bombarded along each of its tributaries.

This same scenario can be observed in an area of at least 100,000 ha in Mato Grosso. The impact on terrestrial and aquatic life is enormous and probably irreversible, because all areas of gallery forest are being destroyed, making forest regenera-

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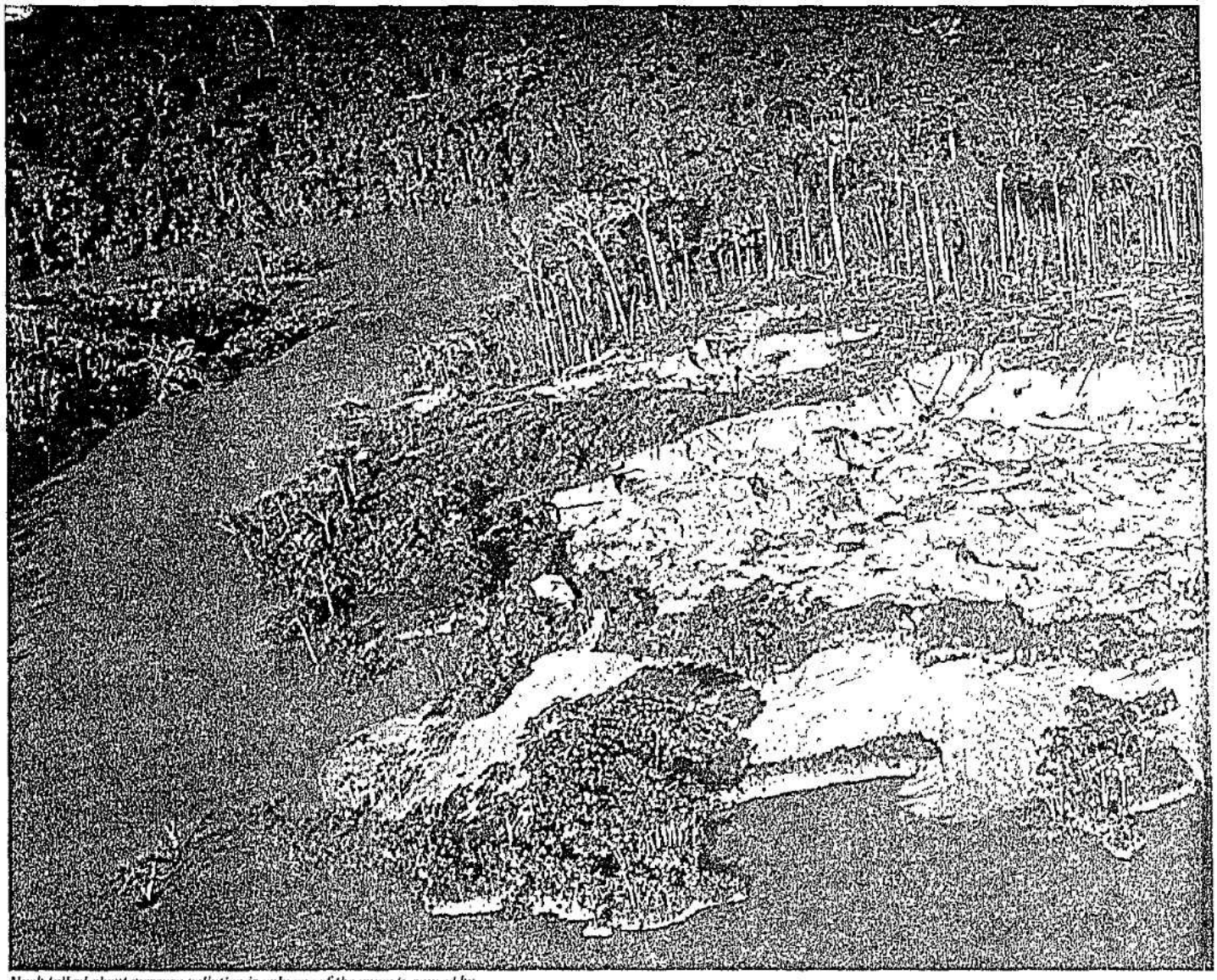


Much talked-about mercury pollution is only one of the impacts caused by placer mining. The policy of devastating the land usually prevails.

tion in the affected watershed very difficult. Fish and other river animals are being exterminated and land animals which must have access to the water are seriously hampered by lack of river bank vegetation.

The water is also being polluted by sediments, mercury residues and chemical elements and compounds which come in contact with the water due to the excavations.

Deforestation, Logging, Hunting and Fishing

Deforestation caused directly by mining activities has not been analyzed, but it most certainly constitutes a serious problem. In the Amazon region of Mato Grosso, around 100,000 ha were cleared or severely degraded by gold mining. Although of lesser magnitude than that caused by agriculture or cattle raising, the destruction of these forests cannot be ignored, because it affects the most fragile part of the ecosystem —— the riverine vegetation, which is protected by law. Two other activities lead to deforestation and adverse environmental impacts. These are construction of thousands of kilometers of access roads into the mining areas, and the widespread establishment landing fields (at least 1100) to serve the gold fields, the towns and the cities.

The forests surrounding each mining area are utilized intensely. Valuable hardwoods used in all types of construction, such as buildings, ports, floats, houses, etc. are exploited. Most miners have at least one firearm for self defense and for hunting, which furnishes an important supplement to a rather meager diet. Hunting is more intense in isolated areas, or where prospecting is expanding to new areas. Fishing is also frequently used to supplement the diet, especially when the miners are off duty.

The Invasion of Indigenous Reserves and Protected Areas

Miners are not usually concerned with land titles. They search for gold wherever it may be found, and if there is gold in an indigenous reserve, they simply go in and stake their claims. If the Indians complain, the miners do everything possible to buy prospecting rights from the tribal chiefs, even though this is illegal (according to today's laws). Agreements with Indian leaders have often been made, in some cases through corruption. The Indians usually foresee no harmful effects from the mining, partly because they receive compensation in much needed benefits and services from the miners.

This information was passed on by several indigenous groups, such as, for example, the Cintas-Largas and the Xingu.

The federal agency responsible for these matters (Funai) is against these agreements, but it lacks the means to enforce the law. There are no official data on the number of reserves invaded by miners, but some sort of activity is taking place in at least 50% of the indigenous territories.

The most famous case involving the invasion of native lands by miners took place in Yanomami territory, State of Roraima. Since 1986, this pristine area of Amazonia has been invaded by 20,000 to 45,000 miners, causing one of the worst cases of human rights violation in the recent history of the region. Around 4000 to 10000 (more likely 5000 to 7000) Yanomamis live there. Isolated from civilization, their natural resources have been plundered, they have been exposed to diseases transmitted by the miners (malaria, measles, dysentery and tuberculosis) and often assassinated in the name of self defense (Barham, 1990; Long, 1990; Kham, 1990; Sevilla, 1990, Brooke, 1990). Their culture is being destroyed. In certain respects, it is a genuine case of genocide. Recent measures by the government to deal with the problem have failed, and anyway, they usually arrive too late.

Like the indigenous reserves, protected areas, or conservation units (national parks, biological reserves and other protected areas), as well as national and state forests have not escaped invasion. Notorious examples are the Amazonia National Park (Pará, 994,000 ha), Pico da Neblina National Park (Amazonas, 2,200,00 ha) and the Gurupi Biological Reserve (Maranhão, 342,000 ha). Two national forests in Rondonia (Jamari and Bom Futuro) are being mined for cassiterite. Besides invasions of protected areas, the mining companies are advancing into and destroying potential sites where studies indicate that the creation of conservation units would preserve biodiversity as well as other important biological traits. This is the case of most of the areas being considered for protection in northern Mato Grosso, an immense state with few conservation units.

The problem becomes more serious when the government officially permits mining in a national forest to relieve pressure on neighboring indigenous lands, such as happened in Roraima. A dangerous precedent was set in the case of the Jamari National Forest, where areas destined for sustained forest production were opened to mining.

SOCIAL CONSEQUENCES

Increased Population Pressure in Amazonia

As Goodland (1990) pointed out in a recent publication, rapid population increase in areas of tropical forests, which

results in intense deforestation, is the leading negative influence on prolonged human activities in Amazonia, especially agriculture and forest exploitation. No activity has attracted so many people to the area in so short a time as the gold rush, which began in 1980. None of the geopolitical strategies which were set forth to fill the *empty spaces* of Amazonia could boast of such startling *success*, and this happened without government investments or incentives. Many miners caught up in this race for riches continue as poor as when they started. Only one in ten manages to make money and to put some away for the future. As always, these are the better-educated ones who begin the adventure with money in their pocket. As a general rule, these people are better off and have more connections, and they normally invest in gold mining. Consequently, some of the miners return to their home states when the gold rush is over. A large percentage, however, swell the ranks of the huge slums which exist in the cities of Amazonia, such as happened during the oil boom in Peru in the early 70's (Rumril, 1982), New slums are also formed, such as Serra Pelada, where 25,000 men, women and children live in abject poverty.

Interruption of the Amazon Way of Life

The traditional life style of those who live on the banks of the rivers in Amazonia has been totally modified by the invading hordes of miners. These river people are employed in the dredge and float operations, because they know the rivers well, or they furnish food and other services, including prostitution.

In any case, activities which sustained these people, such as agriculture, harvesting of forest products, selective logging and others, are being abandoned, even those which they have engaged in successfully for more than a century, such as rubber and Brazil nut gathering. The younger people especially will most likely never return to their traditional life style (always considered to be an extremely stable existence), and will finish their days in the slums of Amazonia or elsewhere. Unfortunately, the natural wisdom of these people concerning the selfsustaining management of riverine areas in Amazonia will vanish forever —— an irreparable loss.

Jeopardizing Rural Development Efforts

The Brazilian government and multilateral agencies, such as the World Bank, have been fostering sustained rural development in the region, mainly in Rondônia and Mato Grosso. Practices such as ecological zoning, permanent agriculture, agroforestry, forestry management, creation of conservation units and

indigenous reserves and other crucial measures have been utilized with great difficulty for the past decade, but with some signs of success. Placer mining activities are becoming a serious threat to these efforts, not only because they destroy agricultural soils and modify farmers traditions, but also because they disseminate diseases such as malaria. An even more serious consequence is the huge increase in prices which cannot be absorbed by agriculture, and which result in these lands being abandoned. Furthermore, civil servants, such as teachers, paramedics, policemen, bank clerks, agricultural extension agents and even a growing number of university graduates quit their jobs to prospect for gold. Doctors are getting rich tending to the miners.

The Spread of Disease

The role of mining activities in the recent malaria epidemic is well-known. The spread of yellow fever from the forest to the cities can also be traced to the miners, as well as the dissemination of measles, tuberculosis and venereal diseases among the Indians. In Mato Grosso, AIDS is reported to be common among the miners and is infecting the local population through prostitution. In August of 1990, 80 cases of AIDS were detected in the gold fields of Roraima.

Corruption and Lack of Law Enforcement

Corruption, crime and nonexistent law enforcement are common in the gold fields and neighboring towns and cities. Drug abuse, robbery and murder are so frequent that they overwhelm the police force, in the rare cases where it exists. The mine bosses carry firearms and hire bodyguards, as do the gold dealers and other members of the gangs involved in smuggling gold out of the country. It has become increasingly clear that drug dealing, gold smuggling, illegal sale of firearms and the traffic of endangered wildlife species go hand in hand. It is surprising to note, however, that accidents in the work place are the leading cause of death among the miners, especially those involved in diving.

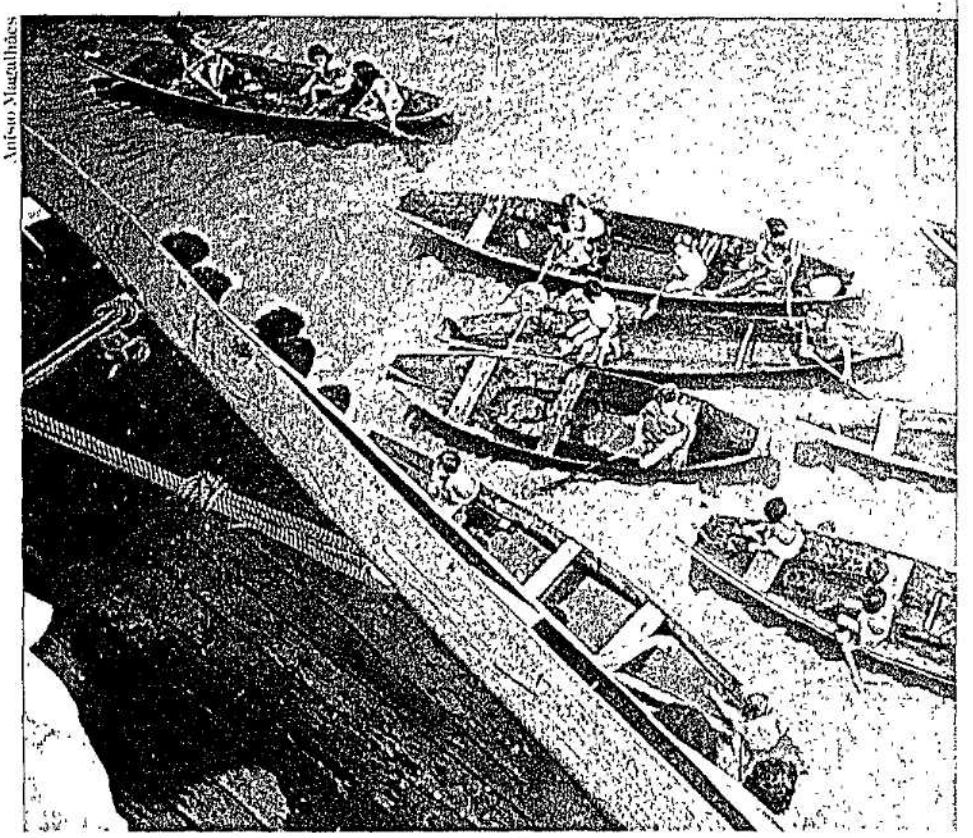
THE FUTURE

Since the beginning of 1990, placer mining activities have been in a slump, mainly because of the new government's economic reforms. However, there is no indication that the gold fever will abate in the near future; the three main reasons for the gold rush are still present: a profound economic crisis combined with unemployment; social injustice and lack of opportunity in Brazilian society, and the enticing price of precious stones and other mineral resources.

Any medium term scenario for the development of Amazonia should therefore take into consideration gold mining activities, but this has not happened. The strategies designed by the Brazilian government to develop Amazonia did not seriously consider this overwhelming problem. What lies ahead then? Gold and other mineral resources are abundant in Amazonia. What will be the most likely social and environmental scenario now that it has been recognized that the problem exists?

The Cost of Doing Nothing

If nothing is done about the problems of the gold fields, they will continue to grow. Many of the social and environmental impacts are cumulative and irreversible, which bodes ill for the future. The invasion of mineral-rich protected areas, resulting in the destruction of fragile ecosystems, such as the gallery forests, would seriously compromise the conservation of biodiversity. Many rivers in Amazonia would become sterile — totally devoid of fish — and large quantities of agricultural soils would be lost. Deforestation would increase. Social consequences include a significant loss of the life styles ideally suited to Amazonia (Indian and riverine populations), plus an outbreak of abject



Antonio Magalhães

Traditional life styles of the river people are changing dramatically due to the ubiquitous presence of the miners.

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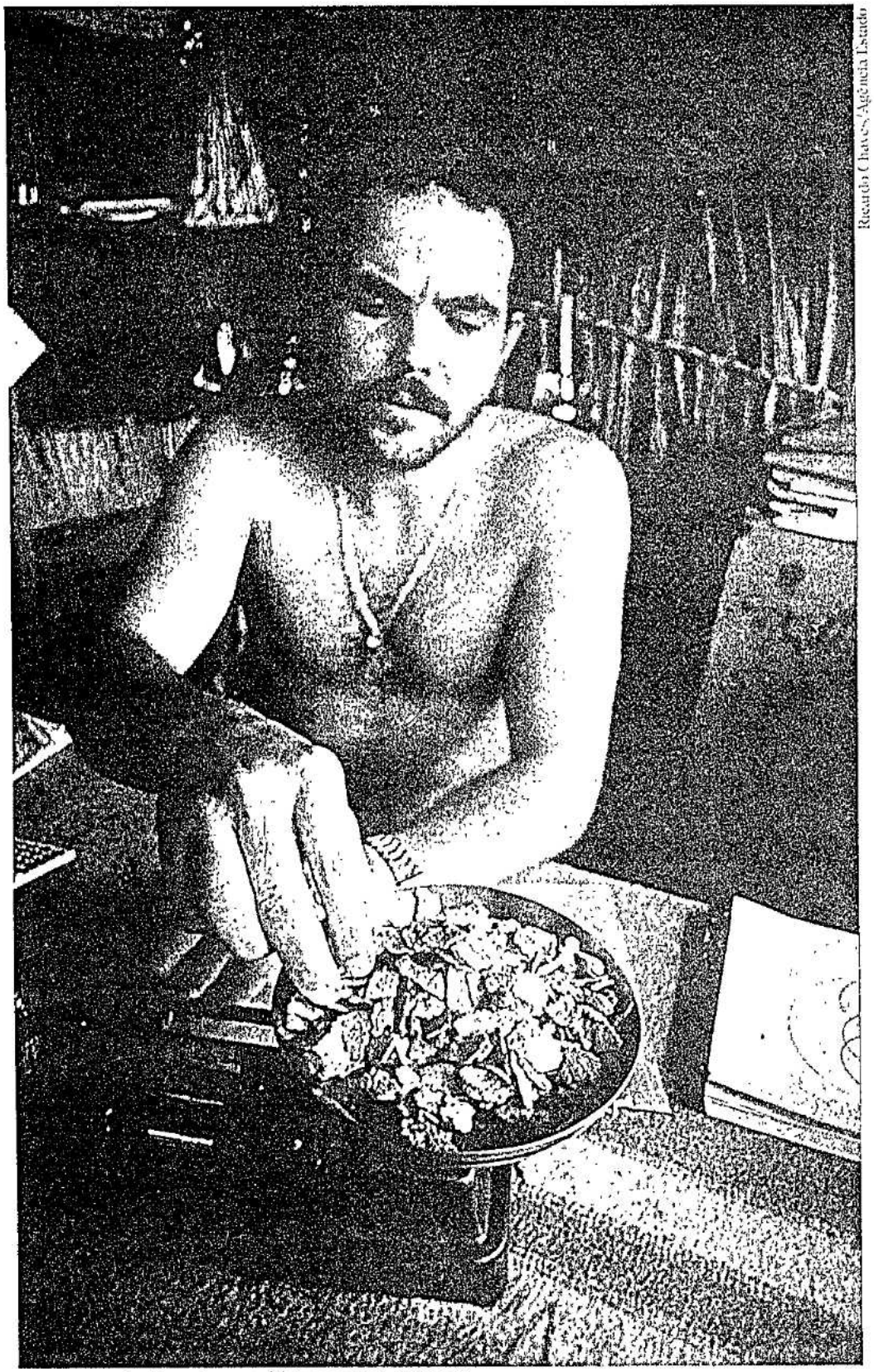
Flávio Canalonga/Abril Imagens

Around 4.5 million people are directly or indirectly involved in placer mining activities in Amazonia; these figures include all service sectors such as finance, health, security and prostitution.



Ricardo Chaves/Agência Estado

In the mines, gold is common currency.

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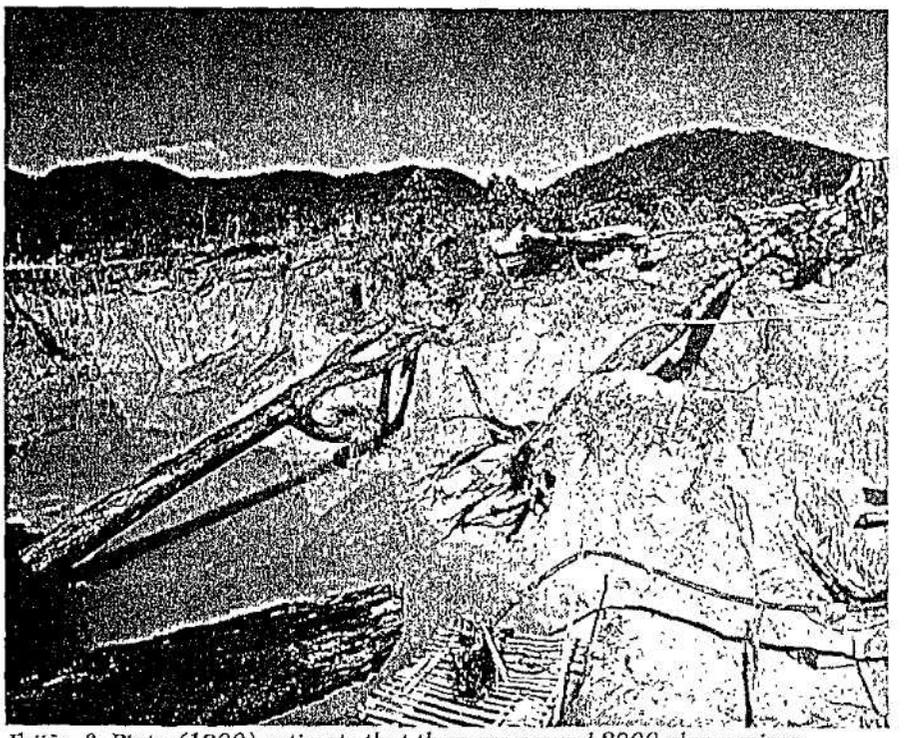
poverty in the cities and the deterioration of all rural development efforts. Furthermore, continued gold mining activities would facilitate a population explosion in the region, making self-sustained development even more difficult to achieve.

The impacts of placer mining activities must be examined in a broader context, together with other social and environmental impacts in Amazonia, such as those caused by cattle raising, agriculture, logging, medium and large scale mining and energy production. New policies which promote acceptable development in Amazonia are endangered by the gold rush. These include the 1989 government project known as "Nossa Natureza" (Our Nature), the social, economic and ecological zoning regulations which have been put into effect in Acre and Rondônia, and are being expanded to Mato Grosso and other states in Amazonia.

Given the remote possibility that gold prices will fall some day, two alternative scenarios are possible: the small mining companies could go broke or be organized into larger, more efficient companies, operating at lower costs. The social and ecological impacts would not go away, but larger companies could perhaps deal more effectively with these impacts.

Antônio Magalhães

No geopolitical strategy designed for the occupation of Amazonia has produced such results as the gold rush which began in 1980.



André Penner/Abril Imagens

Feijão & Pinto (1990) estimate that there are around 2000 placer mines scattered over 100 million hectares of Legal Amazonia.

Gold and Cocaine

The gold mining problem may become as harmful to the environment in Brazilian Amazonia as the growing of the coca plant and production of cocaine is for Andean Amazonia. There is a stong resemblance between the two: they degrade entire watersheds, destroy good soils, seriously pollute the waters, directly and indirectly increase deforestation, invade indigenous reserves and protected areas, promote increased migration to Amazonia, alter the life style of local populations, distort efforts at sustained development and disseminate disease and corruption (Dourojeanni, 1989). Furthermore, gold mining appears to be linked to drugs and part of the profits end up in the drug traffic of Peru and Bolivia. Looking at it this way, the projected road between Brazil (Rio Branco, Acre) and Peru (via Pucallpa or Porto Maldonado) would aggravate the situation.

The Gold Rush in other Countries of Amazonia

Gold is produced in other countries besides Brazil. The Madre de Dios sector in Pachitea Province, Peru, has long been a source of this precious metal (Dourojeanni, 1988). Dredges are

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beginning operations in the Madre de Dios and Inambari rivers; most are owned by Brazilians (Bowen, 1990). Madre de Dios is still the most unspoiled part of the Peruvian Amazon, containing the Me National Park and other valuable protected areas. Gold fever is also a serious problem in Ecuador (Nambija and Guayaimi), Bolivia, Colombia, Guiana and Venezuela. Brazilian miners are operating in neighboring countries, especially Venezuela, according to a recent alert sounded by a congressman, who reported that around 4000 miners had invaded one of the most fragile ecosystems of the Orinoco River basin (Aspurua, 1990). Feijão & Pinto (1990) report that miners are also crossing the frontier into Guiana, Surinam and French Guiana.

Government Action

The federal and state governments in Brazil are obviously not indifferent to the problem. Several legal instruments have been passed recently to regulate placer mining activities, the use of mercury and other environmental aspects of the problem. Many steps have been taken, often in response to protests from local populations which are directly affected by these activities. Some of these measures were very important, others, such as exploding the not-so-secret landing strips in Roraima, were more for show. The serious measures included: 1) the establishment of "prospecting reserves" by the then Mines and Energy Ministry; 2) discussions between the government and the miners associations (USAGAL); 3) more realistic gold prices, to reduce smuggling; 4) orientation for the miners regarding mercury pollution (Rondônia Environmental Agency); 5) health care assistance; 6) incentives to license and improve the gold fields (especially in Rondônia and Mato Grosso); 7) pollution monitoring and research; 8) localized police and military action; 9) studies dealing with the broader aspects of the placer mining problem, such as those done in Mato Grosso (FINEP, 1987) and by DNPM (1985) and CPRM (1985). However, very few of these measures remained in effect for a significant length of time. As a matter of fact, not one was absolutely successful.

WHAT TO DO?

The first step in solving the gold mining problem in Brazil and other countries of the Amazon region is to admit its existence, as well as its true dimensions and social, economic and ecological impacts. The next step is to admit that some form of gold mining or mineral exploitation will always be present in Amazonia. The thought of banishing mining from the region is inconceivable.

Advances in mining technology can be achieved, however, which reflect positively on social and environmental impacts.

The Importance of Zoning

Land use planning, or zoning, is a prerequisite for harmoniously combining economic activities with natural resource potential. This produces especially good results in new territories, where errors can be avoided right at the beginning of the occupation process. Zoning should present an authentic picture of mineral resources, as well as planned uses, as is done with other resources (soils and forests, for example). This aspect was not included in the social, economic and ecological zoning of Rondônia, the first state in Amazonia to adopt this type of planning, but it is being considered in the zoning of other states, especially Mato Grosso. Several measures can be taken when it is decided that some mineral resources will be exploited in zones with a vocation for other activities (Garrido et al., 1989).

Mining Reserves

The establishment of mining reserves, which include the so-called prospecting reserves, can be useful in organizing mineral prospecting, especially if they are designed in accordance with zoning parameters, which reflect the basic national and local priorities. Brazil's mining reserves are established today without duly considering other options of land use and they often coincide with protected areas or those with rich agricultural soils. There is, in fact, a lack of coordination between those responsible for the energy and mining sector and those in charge of the environment or agriculture. Furthermore, information on mineral resources is not always sufficient to make valid proposals, indicating that more research is necessary.

The need for a national level mineral resources policy is often related to problems which must be resolved before effective decisions can be made (Viana, 1989). Mining laws must also be altered in many respects to make possible a better treatment of this issue (Willing, 1989).

Control of the social and environmental impacts described above depends to a great extent on the location of well-organized mining reserves in areas where gold and other mineral resources are abundant and accessible, and where conflicts with other types of land use are minimized. Clearly, one of the conditions for establishing these reserves is that no mining be done in

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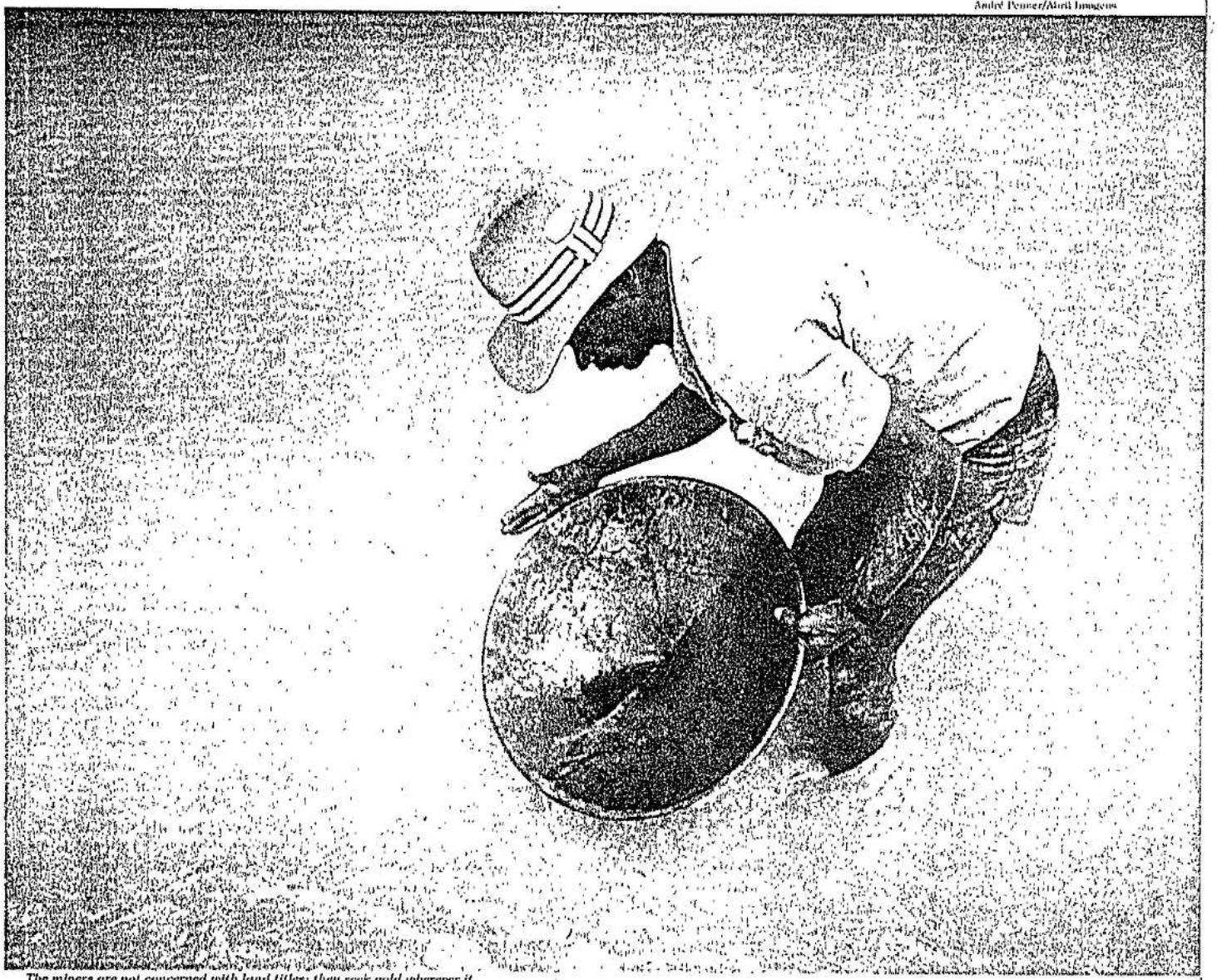
Production of 100 tons of gold in Mato Grosso alone caused the removal and release into water courses of 50 billion m³ of sediments.

other areas. Today's mining reserves are mere traces on a map. Most miners are totally unaware of their existance, or see no advantage in working within their limits. Ideally, mining reserves should be administered by an agency with the authority to impose certain environmental safeguards. They should also provide technical orientation, medical assistence, law enforcement, banking and other services. Gold should be purchased at a reasonable price and accompanied by the collection of taxes. Profits from the reserves should be invested in other activities within the reserves. Brazil's Banco Central and the Caixa Econômica Federal are buying gold, a practice which should be encouraged.

Mining Regulations

Many states, like Rondônia, consistently strive to register and license gold mining claims. The owners of these claims are usually receptive to the idea because they have invested considerable amounts of money in this activity. They prefer nominal regulation to operating illegally. In Rondônia, the environmental control agency is being pressured to approve environmental taxes and to furnish operating licenses for gold mining. Of course, the miners do not readily accept some agency telling them

André Penner/Alerta Imagens



The miners are not concerned with land titles; they seek gold wherever it may be found, and in the process threaten protected areas and indigenous reserves.

where and how they can operate. They do not take most of the recommendations seriously anyway. However, if the government consistently argues for restricting mining operations to reserves, regulation and licensing will become much easier, especially if based on incentives. Environmental taxes collected within mining reserves will become a viable recourse since there will be no need to hunt down each of the thousands of mini-businesses involved, which are constantly on the move from one spot to the next.

The Mercury Problem

Mercury is imported in Brazil. In 1989, the government resolved to keep records on those who import, produce and sell mercury, and also to require that equipment used to recuperate this metal show a 96% efficiency level in order to obtain a license. Of course, these legal measures had very little effect. Regulating commerce does not restrict the amount of mercury available, and the purchase of equipment to recuperate this metal does not guarantee that the miners will use it correctly, if at all. Much more can be done through education and extension work to explain the economic advantages involved in using the equipment, as well as reduced health hazards and environmental impacts. The commerce and transportation of mercury provide the key to enforcing gold mining regulations. If mining is prohibited in a certain area, it is fairly easy to shut off the mercury supply to that area by patrolling the local airports and other key points. The fuel supply can be controlled in the same manner. Because mercury is relatively cheap, it is neither used frugally nor recovered. Heavier taxes would reduce the profits of those who mine gold without recycling the mercury.

From Placer Mining to Modern Day Companies

Many of the worst enviromental and social impacts of placer mining result from the chaotic nature of this activity. Miners rush from one place to another chasing rumors, and after spending fortunes and destroying the environment, the rumors prove to be false and they move on. Disorder and ignorance are also at the root of a vicious circle of human exploitation, which, in the end, rarely fulfills the miner's expectations of riches. These workers are organizing local unions and have formed a national federation (Usagal), which has affiliated six unions, three cooperatives and five associations (Feijão, 1989). Miners cooperatives in Brazil have not been very successful, as Feijão (1988) points

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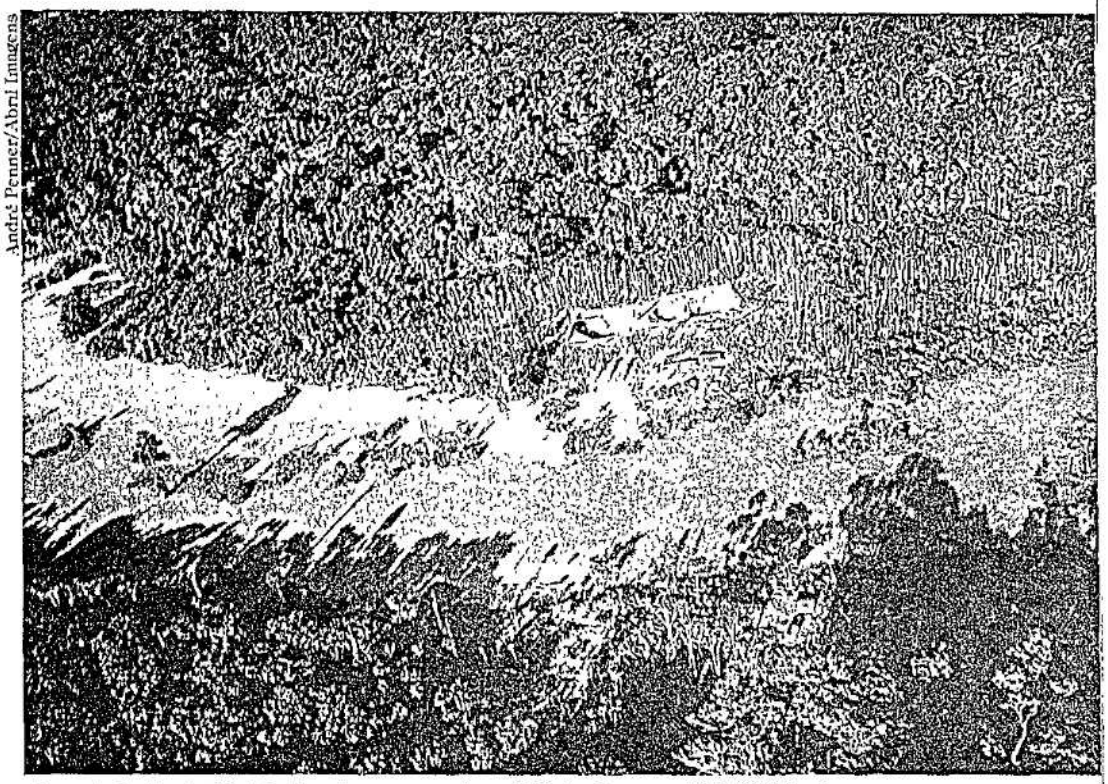

Reports indicate that in the Amazon region of Mato Grosso, 100,000 hectares were deforested or degraded by gold mining. Pará has also been seriously affected (the photo was taken in Itaituba).

Antônio Magalhães

Between 1979 and 1985, an impressive total of 87 tons of mercury were reported to have been dumped into the Madeira River.

André Penner/Abril Imagens

Around 50% of the gold produced in Amazonia apparently results from water-jet extraction.

out, because they offer little or no return for the dues which they collect from their members. However, well organized cooperatives or societies guarantee more efficient and lucrative operations, which in turn furnish greater opportunities and improved social conditions. Large companies are better equipped to handle ecological impacts, under government supervision. A good example of a successful gold mining cooperative was developed in Nambija, Ecuador.

In another vein, contact between Indians and the miners need not always be second-rate. There have been a few examples of good relationships, especially in the case of the Aumaru-Tucuma, where the Maria Bonita and other mines are run by the Indians (Feijão & Pinto, 1990). In the future, the Indians should benefit from the mineral resources found in their reserves.

Finally, placer mining must give way to modern day enterprises, as a solution to the many conflicts which exist. Concepts of equity should be considered as well as legal rights.

Recuperation of Mining Areas and Prevention of Environmental Damage

The recuperation of areas affected by gold production is difficult and costly. Although some impacts are irreversible,

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Salomon Cytrynowicz/Abril Imagens

Mercury is usually separated from gold alongside food preparation activities.

others can be rectified, using the heavy equipment which caused the damage in the first place. When river banks are affected, they can be reconstructed to follow the contours of the original river bed, facilitating colonization by pioneer plants and the gradual recuperation of aquatic ecosystems. Mining techniques which reduce damages exist, but the miners are poorly educated and do not know about these modern methods.

Adequate technical assistance and environmental education can greatly reduce impacts, and at the same time increase efficiency of the operation. Oil and mercury pollution can easily be avoided if there is cooperation from the miners plus government regulation.

Alternatives to Placer Mining

This is a very important aspect of the problem. Many miners come from rural areas and therefore know something about farming. Sustainable agriculture could become a viable alternative to gold mining if certain conditions were met. Profits could be invested in ranching to provide for the future. Investment opportunities could be extended to forest management, ecotourism and agriculture, etc., but special programs should be

developed to reach this objective. On the other hand, a fall in the price of gold is not impossible and would force many miners to abandon this activity. In this case, incorporation of ex-miners and their savings in self-sustaining agriculture, in areas already opened up to settlement, is an attractive alternative.

Creating and Implanting Protected Areas

Conservation of biodiversity in Amazonia can only be guaranteed if management of protected areas or conservation units is effective. Like the indigenous territories, protected areas should be off limits to miners at all costs and law enforcement should be severe. The lack of management (including the absence of definite boundaries) and ineffective enforcement policies has encouraged miners to invade these areas. If this situation could be reversed, biodiversity and native cultures would be safeguarded. Zoning and demarcation of mineral reserves should take this prerequisite into consideration, and should be attentive to the need to create other units.

Making Mining Work for the Country

Brazil, like other countries which have placer mines, could have a lucrative business if this activity were put in order, because the public treasury could collect the necessary funds through taxes, to improve the business and also to solve part of the economic crisis. Today, mine owners pay no county, state or federal taxes. The government should increase its gold buying at just prices, but at the same time, collect its due in taxes.

Working Together

The plan presented here is difficult to carry out in a country with little tradition and social discipline. However, the risks of negligence are so great that even in Brazil, everyone agrees that something must be done. Close cooperation between all the public sectors, both federal and state, is vital if the program is to be successful. An attempt must be made to include the miners, because impartial solutions are absolutely necessary.

Fragmentary efforts, such as are seen today, will only lead to failure and will increase the frustration of the miners and those around them. Biodiversity in Amazonia is critically endangered because there are men who are hungry for gold, as much as

for drugs. The Brazilian government should receive foreign aid so that it can turn placer mining into a sustainable activity instead of a threat to man's survival.

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Marc Dourojeanni — Director of Environment, Interamerican Development Bank, former vice-president of IUCN, former vice-president of the International Commission on National Parks and Protected Areas, former director general of the flora and fauna of Peru, author of several books.

Maria Teresa Jorge Pádua (see Conservation Units chapter)

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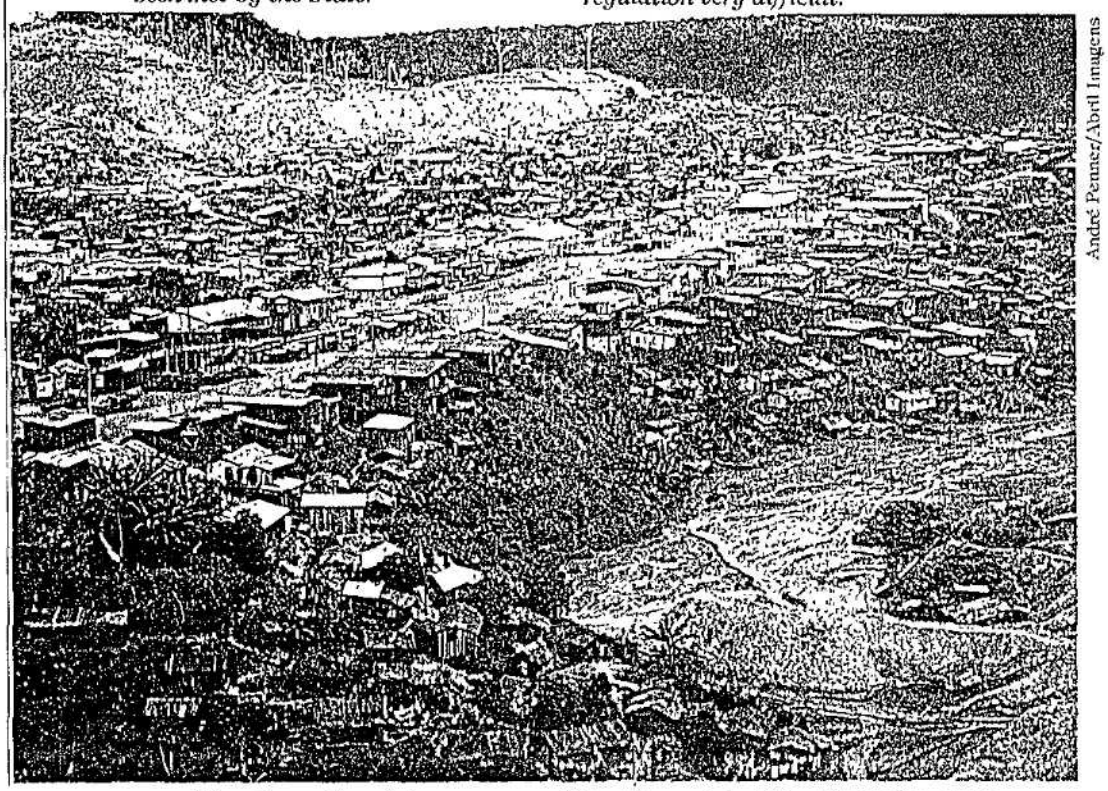
Flávio Cavalcanti/Abril Imagens

The social demands created by placer mining activities have not been met by the State.

Flávio Cavalcanti/Abril Imagens

Serra Pelada, in southern Pará, was overrun by more than 25,000 people, which made regulation very difficult.



André Penner/Abril Imagens

When the gold rush is over, some of the miners go back to where they came from, but many others swell the ranks of the huge slums found in Amazonian cities.

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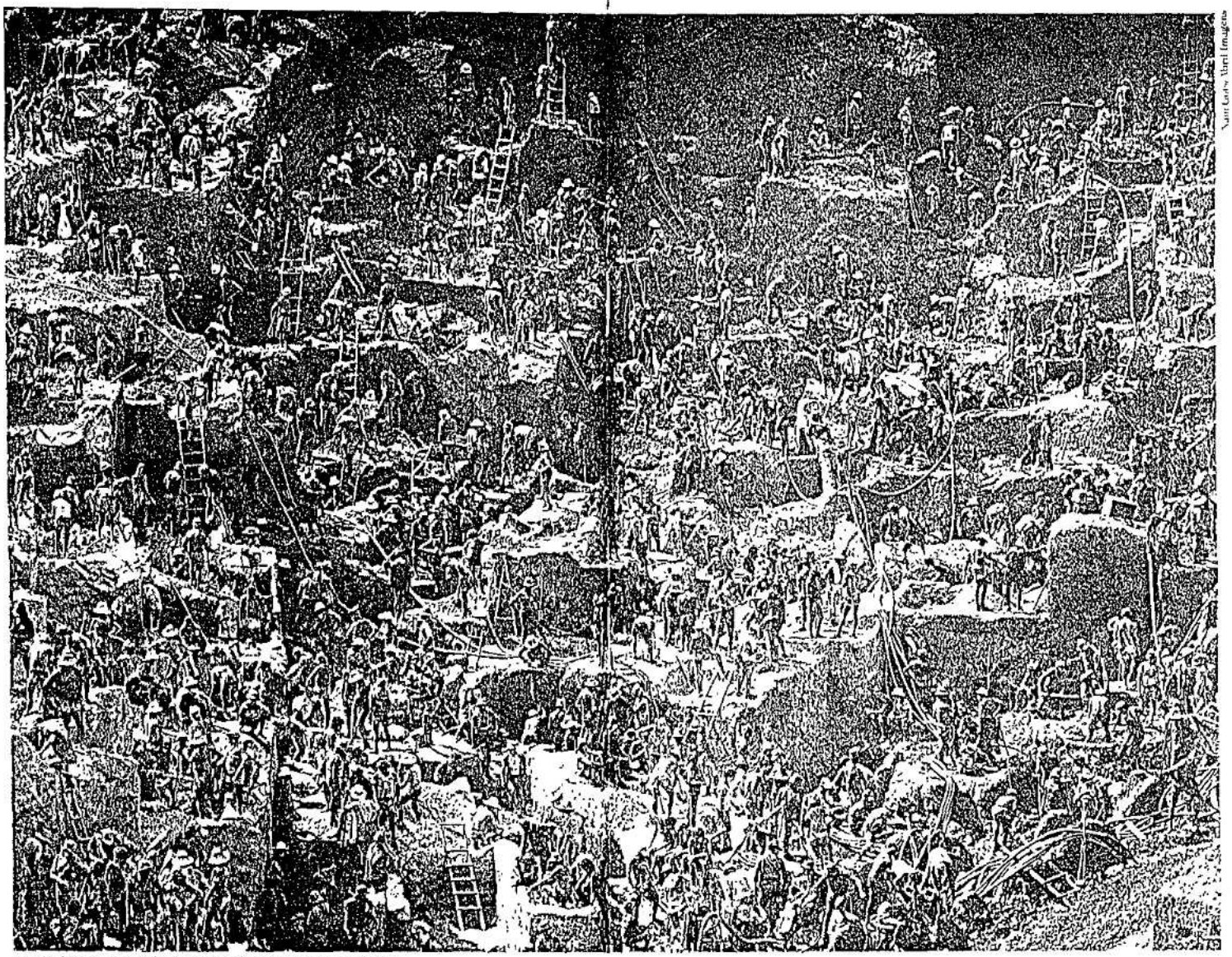
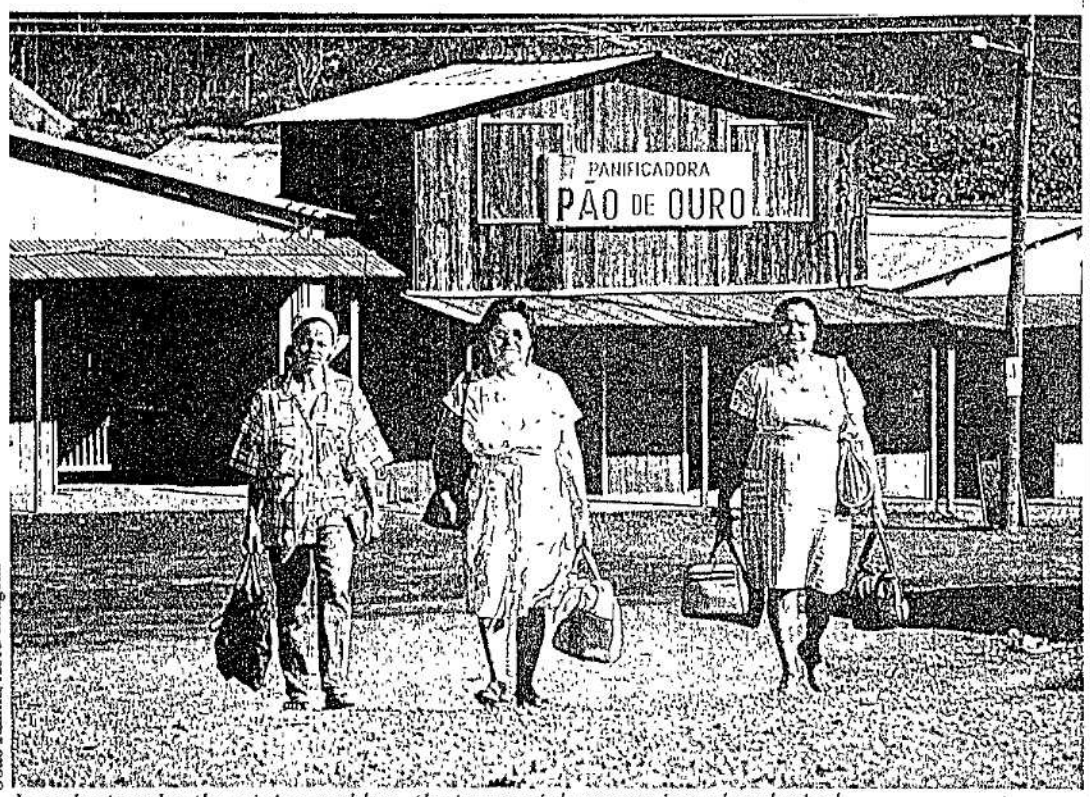


Sam Cody/Still Images

any try but few succeed in the struggle to make and save money



João Ramid/Abril Imagens

In order to solve the mining problem, the true social, economic and ecological dimensions of the issue must first be acknowledged.

Flávio Canalonga/Abril Imagens

Many measures were planned and executed, but few were effectively established or of sufficient duration.

Flávio Canalonga/Abril Imagens

The gold rush threatens the future of the people of Amazonia.