PREVALENCE AND GEOGRAPHICAL DISTRIBUTION OF ENDEMIC GOITRE

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Goitre, as this survey shows in detail, occurs with varying intensity in almost every country; few countries appear to be entirely free from it. The disease has been observed in the far north, in the tropics, and in the far south; it occurs quite independently of climate, season or weather. Moreover, in its incidence goitre makes no distinction of race, nationality, colour, creed or class; the North American, the European, the Chinese, the Himalayan Indian, the Turkoman, and the peoples of Central and South America all suffer from it under certain conditions—some severely, some moderately, some but mildly.

Without doubt the most notorious goitre centres of the world are located in high mountain regions—in Alpine valleys, in the Pyrenees, on the slopes of the Himalayas, and along the Cordillera of the Andes. But goitre is also known to occur with considerable intensity in comparatively low-lying areas and even at sea level; for example, it is seen around the Great Lakes basin between Canada and the USA, in the plains of Lombardy, in the ice-excoriated parts of Finland, and in the low-lying Netherlands. Seven relief maps a showing the distribution of endemic goitre in different areas of the world will be found in the appropriate sections of the text (Fig. 1-7). These maps indicate only where goitre has been found but not the severity of the endemic.

Students of iodine geochemistry have a ready explanation for these diverse phenomena. They say that the types of terrain in which goitre is for the most part found, be they at high altitude or low, are just those which have been subjected either to flooding or to intense glaciation and from which most of the soil iodine has been washed out and carried through the rivers to the sea. During the last Ice Age, earlier soils were swept away

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a These maps have been kindly prepared by Mr C. Dutton, Nitrate Corporation of Chile Limited.
and new soil-making materials were generated by the grinding-up of virgin crystalline rock containing, at the most, one-tenth the average iodine content of mature agricultural soils. As the ice cover receded, replenishment of the iodine in glacial and postglacial soil materials began—a process which is still in progress. The time since the start of this replenishment, that is, the time since the disappearance of the great inland ice-sheets, is estimated to be 10 000 to 20 000 years for the central and northern parts of Scandinavia and the northernmost part of North America, and correspondingly longer for the southern parts of the glaciated areas of Europe and North America. This accords with the fact that the frequency distribution of goitre in North America and in a number of countries in Europe, Asia and Australasia shows a close correlation with the areas and extent of quaternary glaciation where soils have not yet been sufficiently saturated with postglacial air-borne oceanic iodine (see Geochemistry of Iodine).

The number of goitrous people in the world is not known; but if the statistics available for some countries may be taken as a guide, the total is probably not far short of 200 million. Although the geographical distribution of goitre has not apparently altered in the last hundred years, the intensity of the disease has substantially declined in certain countries—particularly those which have enjoyed rising standards of living and an enlightened outlook on public health. The endemics in Switzerland, the USA and New Zealand, for example, have been largely eliminated within the past thirty-five years through the prophylactic use of iodized salt.

Nevertheless, there are many countries where the prevalence of goitre is still exceedingly high and a matter of serious public concern, and many others where the people live so near the critical level of iodine intake that whenever the slender resources of the thyroid gland are abnormally taxed, as, for example, during the nutritional privations of war, epidemic outbreaks of goitre result. Statistics for the year 1952 show that in eight states of Mexico there were over 2 million goitrous people out of a total population of about 10 million; in El Salvador, 329 000 people out of 1 856 000 are affected; Pinotti estimates that there are 11 500 000 cases of goitre in Brazil; in Finland, 2000 operative cases annually out of a population of 3.5 million account for 30 000 days of hospital attendance; in Sweden there are said to be 300 000 people with goitre in a total population of 7 million; Matovinović estimates that some 1 400 000 persons suffer from the disease in Yugoslavia; Hungary has a goitre population of 500 000; and in Italy, Cerletti reckons that no less than 5 million persons are affected, that is, rather more than 10% of the total population. In England and Wales, in 1944, there were estimated to be some 500 000 cases of thyroid enlargement in schoolchildren and young adults; and Taylor has pointed out that the loss sustained by England, Wales and Scotland through failure to iodize salt must be immense if calculated in terms of demands made on the medical services and loss of working time.
In India, there are said to be about 9,000,000 goitre sufferers; and in the USA, the number of men rejected for military service on account of goitre was no less in the Second World War than in the First—namely, five in every thousand examined. It is said that 1,000,000 working men in the USA have hypothyroidism unbeknown to them or their physicians.

These and other similar facts are marshalled country by country in the following pages. The survey is divided into two parts, the first covering the Americas and Europe, and the second, Africa, Asia and Oceania.

THE AMERICAS

North America
Canada; United States of America; Mexico

Central America
Guatemala; Honduras; El Salvador; Nicaragua; Costa Rica; Panama; Cuba; Dominican Republic

South America
Colombia; Venezuela; Ecuador; Peru; Bolivia; Chile; Argentina; Paraguay; Uruguay; Brazil

EUROPE

Northern Europe
Iceland; Finland; Sweden; Norway; Denmark; Estonian SSR, Latvian SSR and Lithuanian SSR; Netherlands

Eastern Europe
Poland; USSR (excluding Estonian SSR, Latvian SSR and Lithuanian SSR); Romania; Bulgaria; Yugoslavia; Albania; Greece

Central and Southern Europe
Austria; Hungary; Czechoslovakia; Germany; Switzerland; Italy, Sicily and Sardinia; Malta; Spain; Portugal

Western Europe
Belgium; England and Wales; Scotland; Northern Ireland; Ireland; France

AFRICA

North-west and West Africa
Algeria; Morocco; Madeira and Canary Islands; French West Africa; Gambia; Sierra Leone; Liberia; Ghana; Nigeria; British Cameroons; Cameroun; French Equatorial Africa; Angola

North-east and East Africa
Egypt; Sudan; Ethiopia and Eritrea; British Somaliland; Uganda; Tanganyika

Central and South Africa
Belgian Congo and Ruanda-Urundi; the Rhodesias; Union of South Africa; Caprivi Strip; South-West Africa; Bechuanaland; Swaziland; Basutoland; Seychelles and Madagascar
ASIA

Eastern Mediterranean
   Turkey; Lebanon; Israel; Iran

Central Asia
   Afghanistan; Pakistan; Kashmir; Nepal; Tibet; India; Assam; Ceylon

Far East
   Burma; Thailand; Indo-China (Cambodia, Laos and Viet Nam); Malaya; Indonesia;
   Sarawak; North Borneo; China; Korea; Taiwan; Japan; Philippine Islands

OCEANIA

Australasia
   New Guinea; Australia and Tasmania; New Zealand

Pacific Ocean
   Fiji Islands; Tonga (Friendly Islands); Cook Islands; Hawaiian Islands

The occurrence of endemic goitre has been recorded in all the above countries. So far as can be ascertained there is no published information relating to countries not named above.

Among those who have previously dealt comprehensively with the geographical distribution and prevalence of endemic goitre on a continental or world scale are: Hirsch, Saint-Lager, Bircher, Clemow, McCarrision, Eggenberger, De Quervain & Wegelin, Pflüger, McClendon, Greenwald, the Chilean Iodine Educational Bureau, London, and the Oficina Educacional del Yodo, Santiago, Chile.

PART I—THE AMERICAS AND EUROPE

Canada

Proceeding through Canada from west to east, centres of goitre are first encountered in British Columbia. Some 50 or 60 miles from Vancouver, going inland from the head of Howe Sound, the disease is found in the Pemberton valley and in the area watered by the Lillooet and Birkenhead rivers. An interesting account of this district has been given by Keith, who relates that fifty years ago European settlers in Pemberton Meadows suffered so severely from goitre, both in themselves and among their cattle, pigs and horses, that they almost decided to leave the valley. Writing in 1949, MacDermot records that owing to the administration of supplementary iodine in food and drinking-water, Pemberton Meadows is now a healthy and thriving community.

\[1 \text{ mile} = 1.6 \text{ km.}\]
The red hatching indicates the areas where endemic goitre has been found.
The coastal valley of Bella Coola, 270 miles north-west of Vancouver, is also peculiarly sensitive to the disease. Other areas of considerable prevalence in British Columbia lie to the east and north-east of Vancouver. These are the valley of the Lower Fraser river, the town of Kamloops, around Lake Okanagan at Keremeos, Penticton and Vernon, and thence northwards, including such places as Armstrong, Enderby and Salmon Arm. Farther east, goitre occurs in the neighbourhood of the Arrow Lakes and in the valleys towards the Selkirk Mountains. To the north there are centres in the Cariboo Mountains, at the town of Prince George, and all along the Grand Trunk Pacific Railway as far as Edmonton in Alberta.

In Alberta, Walker has seen a great deal of goitre in a strip of territory running due south from Edmonton to the northern border of the United States. Places affected are: Leduc, Wetaskiwin, Lacombe, Eckville, Red Deer, Big Valley, Olds, Didsbury, Calgary, High River, Champion and Cardston. It is also prevalent in the southern districts irrigated by the South Saskatchewan river from Lethbridge and Taber through Medicine Hat to Gull Lake.

Another part of Alberta where goitre is fairly common lies to the north-west of Edmonton in the area drained by the upper waters of the Peace and Athabaska rivers, and including such centres as Sexsmith, Peace River and Barrhead. An early account of goitre in this general area is given by Dr John Richardson, surgeon and scientist on Franklin’s famous expedition to the polar seas in the north-west of Canada between 1819 and 1822. “At Edmonton”, he notes, “the disorder attacks those only who drink the water of the river. The inhabitants of Rocky Mountain House, sixty miles nearer the source of the river, are more severely affected than those at Edmonton; but at Carlton House, a considerable distance below Edmonton, the disease is known only by name.” Other writers who refer to former and more recent occurrences of goitre around Edmonton and in the basins drained by the two branches of the Saskatchewan river are Simpson, Hector, and T. H. Whitelaw (personal communication to F. J. Shepherd).

In Saskatchewan there are accounts of goitre at Saskatoon. According to Binning, a prevalence among schoolchildren of 12.3% in 1934 has been greatly reduced by the administration of iodine in various forms. Goitre is also found farther south, in the country immediately surrounding the town of Regina. Other centres are at Qu’Appelle, between Regina and Indian Head; at Bethune, Govan, Raysmore, Cupar and Ituna, north of Regina; and in a strip of country running from Shaunavon eastward to Weyburn (Jackes).

Goitre studies of schoolchildren have been made at widely separated places in Manitoba. At Dauphine, in the west of the province, 74% of the children were affected. In the south, 21% of children at Morden had goitre. At Winnipeg the goitre rate was 50%, and in the towns of Birds Hill and
Stonewall, both in the Winnipeg area, 85% of the children were sufferers. The Indian School at Waugh, in the extreme east of the province, was free from goitre. These particulars are taken from the publications of Hamilton & McRae and of Abbott. Evidence of iodine deficiency among people in Winnipeg has also been noted by Edward.

The land areas surrounding the five Great Lakes lying across southern Ontario and the states of Wisconsin, Michigan, Ohio, Pennsylvania and New York in the north-eastern United States have long been recognized as notoriously goitrous. Goitre literature abounds in references to the disease in this area, in both animals and man. Edward observed it in the Japanese Prisoners of War Camp at Angler on the north shore of Lake Superior.

Sixty years ago, Springle and Adami recorded goitre, or "grosse gorge", as common throughout the Laurentian mountains of Quebec especially in the counties of Terrebonne, Berthier, and St. Maurice. The disease was also frequent in the lower-lying country around Montreal at such places as Vaudreuil and Beauharnois. More recently, Greenwald (personal communication to WHO, 1958) has expressed the opinion that goitre is probably still common in the Montreal area and along the St. Lawrence to at least eighty miles below Quebec. In a nutrition survey of the Indian people inhabiting the townships surrounding James Bay—the southern extension of Hudson Bay—undertaken by the National Committee on Community Health, small goitres were found in 5.3% of 728 subjects examined. The majority were in young women (Vivian et al.). Since 1945 all salt sold through the Hudson's Bay Posts has been iodized. Canada, as a whole, adopted compulsory iodization of table salt in 1949.

In the Province of Newfoundland, goitre was observed but once only among 868 unselected people from St. John's and five outports, who were examined for clinical biochemical evidence of abnormalities due to defective nutrition (Adamson et al.). The fact that consumption of fish is high no doubt accounts for iodine sufficiency in Newfoundland.

United States of America

Although in recent times goitre has been largely overcome through the increasing use of iodized salt, the disease is still recognized as a serious regional health problem in the USA. Starr reported in 1958 that among 4500 men in industry in southern California 7% had thyroid deficiency. Projecting these findings, he estimates that one million working men in the USA have hypothyroidism unbeknown to them or their physicians.

Considered in broad outline, and geographically from east to west, the goitre centres of the USA are found throughout the whole length of the Appalachian range, in all states bordering on the Great Lakes, westward through North Dakota, and into the far western states of Montana, Idaho, Utah, Oregon and Washington where the incidence is particularly heavy.
Except for isolated pockets of high incidence in Kansas—especially where it borders on Missouri—and in the New Orleans district of Louisiana, the great central plains are comparatively goitre-free, as also are the states on the Atlantic seaboard and the southern states of Mississippi, Alabama, Georgia and Florida.

The first reliable index of the over-all prevalence of goitre in the USA resulted from the examination of 2,510,701 men drafted for military service during the First World War. Nearly 12,000 men had simple goitre and 31% of these were rejected because their necks were so large that the collar of the military tunic could not be buttoned around them. The frequency of the disease was greatest among recruits from the States of Washington, Oregon, Montana and Idaho in the north-west and from the region of the Great Lakes. It was least in men drafted from the southern and Atlantic coast states and most frequently seen in those of Scandinavian origin.

Later, between the years 1923 and 1929, systematic goitre surveys of elementary schoolchildren were made in various states by the US Public Health Service. The results revealed a general distribution very much the same as that shown by the earlier military survey, except that whereas the examination of drafted men disclosed the highest incidence in the states of the Pacific North-West, the surveys of the Public Health Service indicated the greatest incidence to be in certain areas of the Middle West, that is, in Ohio, Indiana, Illinois, Michigan, Iowa, Wisconsin and Minnesota—states grouped around the Great Lakes.

Goitre rates in these areas were found to be high. For example, in the town of Cincinnati (Ohio), 26% of the boys and 40% of the girls were classed as having simple thyroid enlargement. In the State of Minnesota the endemic was even more severe, 41% of boys and 70% of girls from 13 different localities showing evidence of thyroid enlargement. Conditions in Michigan and Wisconsin were no better; rates of 40%, 60%, 70% and even 100% were reported among boys and girls from certain localities in these states.

Throughout the eastern states, although some moderately high percentages are recorded by the Public Health Service, there is on the whole much less goitre than there is around the Great Lakes and in the Far West. The State of Connecticut gave rates of 7% in boys and 29% in girls, and Massachusetts 9% in boys and 22% in girls. There is almost no goitre in territories east of the Blue Ridge Mountains. Indeed, South Carolina is famed for the fact that her fruits and vegetables have a high iodine content and that, in consequence, goitre incidence there is negligible.

As regards the Far West, statistics collected by the Public Health Service in the State of Colorado revealed thyroid enlargement in 25% of boys and 30% of girls. Utah is a notoriously goitrous state, very high rates being found in the locality of Salt Lake City. In Oregon, thyroid enlargement prevailed in 22% of boys and 38% of girls. Goitre is endemic to a
considerable extent in the coast towns of Oregon, exemplifying the fact that proximity to the sea does not necessarily guarantee freedom from the disease. Darby and his colleagues found almost no goitre among the Navajo Indians scattered throughout the arid lands of north-eastern Arizona.

The goitre situation in the Middle West—particularly in Ohio and Michigan—has greatly improved in recent years owing to the introduction of iodized salt and the official encouragement given to its use. Brush & Altland have reviewed the results of thirty years of goitre prevention with iodized salt in this area. Their survey carried out in four Michigan counties in 1951 showed a goitre rate of 1.4% in 53,785 students, compared with a rate of 38.6% in 65,537 students from the same counties examined in 1924. Similarly, in Ohio the problem of enlarged thyroid is not nearly so acute as it was 35 years ago. A survey of 22,402 children in four Ohio counties, completed in the spring of 1954 (Hamwi), showed only 4.05% with enlarged thyroids. This compares with a prevalence of 32.3% among 21,580 children examined in the same counties in 1925.

Some idea of the significance of goitre in the USA may also be gained from the medical examination records of registrants for military service during the Second World War. Referring to the occurrence of thyroid disease among 13 million men examined up to January 1944, Rowntree says that during peacetime all doubtful cases were considered significant, with the result that the rate was 5 per 1000, but, as manpower for the fighting forces became scarcer, only the more outstanding clinical pictures were labelled actual disease—a fact which resulted in a recorded rate of 0.6 per 1000. Hyperthyroidism, in both war and peace, was more frequent than hypothyroidism, he adds.

Details of the US Public Health Service investigations quoted above are taken from Olesen. Other authorities consulted are Adolph & Prochaska (Nebraska), Altland & Brush (Michigan), Cavanagh (Washington), Daft (Michigan & Ohio), Darby (Navajo Reserve), Foote (lower San Joaquin Valley, California), George & Flory (lower Rio Grande Valley, Texas), Greenwald (West Virginia), Greenwald (Ohio & West Virginia), Grollman & Gryte (western North Carolina), Hamwi et al. (Ohio), Hull (Colorado), Johnson (Kentucky), Jordan & Canuteson (Kansas), Kenyon, Kelly & Macy (Great Lakes), Kimball (Ohio & Michigan), Mahorner (southern states), Mahorner & Barrow (Deep South), Marine (Ohio), Miller (Great Lakes), Pennington (Kentucky), Phillips (Texas), Phillips (south-western Virginia), Richards (Utah), Rowntree (recruits), Starr (southern California).

Mexico

In the upper basin of the Rio Grande del Norte begins a great Central and South American zone of goitre comparable with the vast endemics
of the Alps and Himalayas. It extends through Mexico and the Central American Republics into Colombia and Venezuela, along the Cordillera of the Andes through Ecuador and Peru as far as Chile and western Argentina.

According to Stacpoole, the greatest goitre authority in Mexico, endemic centres are found in all Mexican states bordering the Pacific except lower California. Goitre also affects the mid-central and southern parts of the country. The north-central gulf-coast of Tamaulipas and the Caribbean regions of Campeche, Yucatan and Quintana Roo are practically exempt. Most of the goitre centres are situated in the mountains, but there are stretches along the Pacific coast where the disease is also to be found.

Up to the end of 1952, Stacpoole and two colleagues had examined more than one million children and adults in eight mid-central states, with a total population of over 10 million. The results of the survey (see Table I)

<table>
<thead>
<tr>
<th>State</th>
<th>Total population</th>
<th>Cases of goitre</th>
<th>Prevalence (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distrito federal</td>
<td>3 309 367</td>
<td>165 468</td>
<td>5</td>
</tr>
<tr>
<td>Puebla</td>
<td>1 691 950</td>
<td>406 066</td>
<td>24</td>
</tr>
<tr>
<td>Michoacán</td>
<td>1 470 837</td>
<td>385 359</td>
<td>26</td>
</tr>
<tr>
<td>México</td>
<td>1 443 681</td>
<td>425 886</td>
<td>30</td>
</tr>
<tr>
<td>Guerrero</td>
<td>952 037</td>
<td>281 811</td>
<td>27</td>
</tr>
<tr>
<td>Hidalgo</td>
<td>861 521</td>
<td>303 282</td>
<td>35</td>
</tr>
<tr>
<td>Morelos</td>
<td>291 119</td>
<td>135 661</td>
<td>46</td>
</tr>
<tr>
<td>Tlaxcala</td>
<td>290 592</td>
<td>108 972</td>
<td>37</td>
</tr>
<tr>
<td>Total</td>
<td>10 311 104</td>
<td>2 192 505</td>
<td>20</td>
</tr>
</tbody>
</table>

indicate that in these eight states there are more than two million people afflicted with goitre, that is, a rate of about 20% for the whole area.

The survey covered 3756 towns and villages within 858 townships. Rates of more than 80% were common in many places and in some communities upwards of 90% of the population were found to be goitrous.

According to law, all municipalities in which more than 20% of the population are affected by goitre are obliged to use iodized salt exclusively, and energetic measures are being taken to overcome the administrative difficulties that prevent enforcement of the law. Since 1950 prophylaxis by means of iodized sweets has been carried out among 50,000 children in 45 schools in the Federal District and in 80 schools in the State of Morelos. The result has been an average drop of 16% in goitre prevalence among children in these schools.
More recent experience in Mexico confirms the existence of very high goitre rates in certain provinces and has proved the prophylactic reliability of salt iodized with iodate instead of iodide. Stacpoole has devised a new salt-iodizing plant, capable of producing 5 tons per hour, expressly designed to serve local requirements in severely endemic areas. In his description of this process he gives an account of some of the difficulties encountered with producers and purveyors of salt during the installation and initial operation of the machine at Pinotepa Nacional, Jamiltepec, in the province of Oaxaca, where in some localities goitre affects 80%-90% of the population.

Historical aspects of goitre in Mexico and Central America are dealt with by Greenwald.

Central America

Since the establishment of the Institute of Nutrition of Central America and Panama (INCAP) in 1949, extensive surveys have been made to determine the prevalence of endemic goitre in Central America. As a result, it has been shown that the disease is a serious public health problem in Guatemala, Honduras, El Salvador, Nicaragua, Costa Rica and Panama.

Guatemala

A survey made in 1938 by Herrera confirmed earlier findings by Guerrero (1908) and by Díaz (1918) that goitre is a serious condition in Guatemala, affecting 50% of the people in some localities. Dr Herrera established seven goitrous zones involving 16 departments: (1) Chimaltenango, Sacatepéquez, Sololá, the northern part of Escuintla and Suchitepéquez, and the southern part of Quiché as far as Totonicapán and Quezaltenango; (2) El Progreso and the south-west part of Zacapa; (3) the north-west part of Jutiapa and part of Jalapa; (4) the north-west of Quezaltenango and San Marcos; (5) the south of Huehuetenango; (6) the north-west of Huehuetenango; (7) the north-west of Santa Rosa. The Department of El Progreso showed the highest prevalence.

The most modern statistics are those compiled by Mahorner and by Scrimshaw and his co-workers in INCAP. They have found an overall prevalence of 38.5% in the Departments of Guatemala, Escuintla, Chimaltenango and Sacatepéquez, some regions of which showed rates varying between 60% and 74%. Interested also in the history of goitre, Borhegyi & Scrimshaw have marshalled evidence from archaeological and other sources pointing to the fact that goitre existed in Guatemala hundreds if not thousands of years before the conquest of the country by the Spaniards in 1524.
Nodular goitres are common in the highlands of Guatemala; by contrast, nodular goitres are uncommon in El Salvador. Deaf-mutism and idiocy are frequently found in association with iodine deficiency in the highly endemic areas of Guatemala. These sequelae were not observed in El Salvador. Writing of conditions in Guatemala as he encountered them in 1950, Kimball \(^{72}\) says: "I have never seen such degeneration; feeblemindedness and deafmutism were very frequent."

Energetic official action is being taken to combat goitre in Guatemala by means of iodized salt. Both iodate and iodide in doses of equivalent iodine content have been tested and found equally effective. Experiments on Guatemalan children reported by Scrimshaw and his colleagues \(^{74},^{77}\) show that after 32 weeks of treatment the goitre rate was reduced from 51\% to 16\% with iodate, and from 60\% to 23\% with iodide.

**Honduras**

In common with most other Central American countries the over-all prevalence of goitre in Honduras is high. As part of the INCAP goitre survey, Borjas and Scrimshaw \(^{78},^{79}\) examined a total of 12,292 schoolchildren and 352 adults, comprising nearly 1\% of the population in all 15 departments, and found that nearly one-fourth (22.6\%) of these people had pathologically enlarged thyroid glands. Slightly less than 14\% of the goitres were readily visible with the head in normal position and fewer than 1\% had discrete nodules. The highest rates occur in the Ajuterique and Lejamani districts of the Department of Comayagua (73\% and 74\% respectively) and in the La Venta area of Morazán Department (64\%).\(^{71}\)

**El Salvador**

Goitre is endemic in all 14 departments of El Salvador.\(^{81}\) During 1952 nearly 35,000 schoolchildren of all ages from public and private schools in urban and rural areas were examined by a goitre survey team under the auspices of INCAP. Glands were not considered enlarged unless they were definitely four to five times the "normal" size.\(^{65},^{80},^{82}\)

Of 8000 children examined in the capital (San Salvador) only 1.1\% were found to have thyroids more than four to five times the normal size. Among the 26,400 children examined in the remainder of the country the average rate was 22.8\%, with variations between 8.5\% and 38.7\%, depending on the department. Deaf-mutism, idiocy and cretinism were not observed. The worst affected department was Ahuachapán.

On the basis of these studies, it is calculated that 119,000 children in El Salvador out of a total school population of 673,000 are affected with goitre. If these average figures for schoolchildren can be taken as reasonably representative of the population as a whole, El Salvador would have 329,000
goitrous people out of a total population of 1 856 000 (Cabezas, Pineda & Scrimshaw 85).

Nicaragua

An examination of 2427 children carried out in 1954 under the auspices of INCAP gave the results shown in Table II (N. S. Scrimshaw—personal communication, 1954):

<table>
<thead>
<tr>
<th>Department</th>
<th>District</th>
<th>Number of children examined</th>
<th>Number with goitre</th>
<th>Percentage with goitre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carazo</td>
<td>Santa Teresa</td>
<td>157</td>
<td>85</td>
<td>54.1</td>
</tr>
<tr>
<td></td>
<td>Diriaamba</td>
<td>223</td>
<td>44</td>
<td>19.7</td>
</tr>
<tr>
<td></td>
<td>Jinotepe</td>
<td>438</td>
<td>57</td>
<td>13.0</td>
</tr>
<tr>
<td>Masaya</td>
<td>Nindiri</td>
<td>90</td>
<td>20</td>
<td>22.2</td>
</tr>
<tr>
<td></td>
<td>Masaya</td>
<td>224</td>
<td>32</td>
<td>14.3</td>
</tr>
<tr>
<td>Managua</td>
<td>San Rafael del Sur</td>
<td>117</td>
<td>62</td>
<td>53.0</td>
</tr>
<tr>
<td></td>
<td>El Salto</td>
<td>51</td>
<td>23</td>
<td>45.1</td>
</tr>
<tr>
<td></td>
<td>Las Maderas</td>
<td>72</td>
<td>28</td>
<td>38.9</td>
</tr>
<tr>
<td></td>
<td>Montelimar</td>
<td>47</td>
<td>12</td>
<td>25.5</td>
</tr>
<tr>
<td></td>
<td>Managua</td>
<td>457</td>
<td>98</td>
<td>21.4</td>
</tr>
<tr>
<td></td>
<td>Tipitapa</td>
<td>35</td>
<td>1</td>
<td>2.9</td>
</tr>
<tr>
<td>Matagalpa</td>
<td>Matagalpa</td>
<td>355</td>
<td>81</td>
<td>22.8</td>
</tr>
<tr>
<td></td>
<td>C. Darío</td>
<td>161</td>
<td>7</td>
<td>4.4</td>
</tr>
</tbody>
</table>

| Total . . . | 2 427           | 550                        | 22.6               |

These statistics indicate an average goitre rate of 22.6%. In the districts of Santa Teresa (Carazo) and San Rafael del Sur (Managua) the rate exceeds 50%.

Costa Rica

Goitre statistics for Costa Rica are few, but they are sufficiently disquieting to justify the official introduction of preventive measures. García 86 found a rate of 10.6% among male patients in a mental hospital. He also refers to a series of 1000 autopsies in which 45 goitres were noted. Investigations in the canton of Puriscal by Urcuyo 87 revealed 27 cases of thyroid abnormality among 1000 people examined ; 6 of these cases were in men and 21 in women.
More recent surveys by INCAP (N. S. Scrimshaw—personal communication, 1954) revealed an average rate of 12% among 24,000 children examined. The following are the figures for five of the seven provinces: Alajuela, 17%; Cartago, 12%; Heredia, 15%; Limón, 6%; San José, 8%.

Lack of iodine in drinking-water, monotonous diet, and hardness of water are considered by De Girolami & Fallas Diaz 84 to be the causes of the Costa Rican endemic. Cases of cretinism and deaf-mutism are of sporadic occurrence.

Panama

The Peruvian expert, Dr Arce Larreta, examined a total of 3540 persons in the Province of Chiriquí as part of the INCAP survey. 71 He found goitre rates as follows: 2.5% in children up to 6 years of age (808 examined); 50% in children of school age (1682 examined); and 75% in adults of 18 years or over (1050 examined).

More recently Reverte Coma 88-91, 93 has carried out extensive goitre surveys throughout Panama. In Herrera and Chame the following percentage prevalences were noted:

<table>
<thead>
<tr>
<th></th>
<th>Pre-school children</th>
<th>Schoolchildren</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Herrera</td>
<td>6.80</td>
<td>60.81</td>
<td>46.85</td>
</tr>
<tr>
<td>Chame</td>
<td>1.05</td>
<td>21.18</td>
<td>17.81</td>
</tr>
</tbody>
</table>

Many cases of cretinism and deaf-mutism were found. Reverte Coma 92 has also studied the “Anne Boleyn” syndrome, the name given by Marañon and his school to the simultaneous existence of goitre and polydactylysm in a patient. He estimates that cases of polydactylysm on the Panama Isthmus number 1 in every 2000 or 3000 inhabitants, the majority being from areas where goitre is endemic.

Cuba

Zones of endemic goitre do not apparently exist in Cuba. Nevertheless, sporadic cases occur with more than usual frequency in the regions of Sagua de Tánamo, Morón, and Ciego de Avila. Three of these, all in one family, have been described by Schutte et al. 94

Dominican Republic

According to Purcell 96 numerous cases of simple goitre are found in Santo Domingo. He mentioned El Cerado, El Pinar, Los Arroyos, El Coco and Los Naranjos as the districts most affected.

De León 95 refers to the frequency of goitre among the country people in the mountainous zone of Jarabacoa. Women, and children between the
ages of 10 and 14 years, are especially prone to the disease. The condition is accompanied by under-development, sexual immaturity, idiocy and cretinism. Sterility and other manifestations of reproductive failure are common among women. The goitre seen in these areas is characteristically benign; toxic phenomena are never seen. La Pelada, El Salto, Manabao, Pinarquemado, Boma, La Peña and Vera Bellica are the most affected sections in this area. If iodine treatment is applied in childhood excellent results are obtained. Nothing can be done medically to alleviate goitres in patients over the age of 20 years.

South America

From earliest times the continent of South America has presented a fruitful field of study for the goitre investigator. Crotti\(^7\) recounts how the first explorers of New Granada (now Colombia) were astonished to find the banks of the Rio Magdalena inhabited by a race of “heavy and stupid savages of sluggish habit who passed their days in sleep.” Among the goitrous Indians of the Peruvian plateau, cretinism had reached such a degree in those days that it required nothing less than a papal bull from Paul III (d. 1549) to convince the missionaries that these were indeed men with souls to be evangelized. On the other hand, painstaking historical research has convinced Greenwald\(^8\) that goitre was unknown in the Inca Empire and did not appear there (i.e., in Colombia, Ecuador, Bolivia, Peru, Chile and Argentina) until after the Spanish conquest of these countries. This is in line with the views of Bengoa.\(^117\)

Today, the disease is found in almost every country of South America. Summaries of the history, prevalence and geographical distribution of goitre in South American countries up to the year 1950 have been made by the Chilean Iodine Educational Bureaux of London and Santiago.\(^2\)\(^3\) Orr\(^9\) and Kimball\(^72\) are two other authorities who have written interesting general accounts of goitre in South America.

Colombia

Endemic goitre in Colombia is a problem of long standing. Mutis\(^110\) reported in 1794 that he had seen goitrous people on the upper Magdalena River in 1760, that is, more than thirty years prior to the date of the written record. In 1797 Gil de Tejada\(^103\) wrote about the cause and cure of the disease in Santafé (Bogotá). Francisco José de Caldas, noted Colombian naturalist and patriot, repeatedly mentions goitre in his writings (1808). Apparently he was the first to attribute the disease to the quality of the local drinking-waters—some excessively charged with lime and others with calcium sulfate, iron, and decaying vegetation. About the same time (1810) Camacho studied the distribution and extent of the Colombian endemic and observed that the disease was frequent in the convents of
The red hatching indicates the areas where endemic goitre has been found.
Bogotá, where well water of exceptional hardness was used for drinking and cooking purposes (Socarrás 113).

A special interest attaches to the story of goitre in Colombia because it was there that the famous French scientist, J. B. Boussingault, 106, 101 put forward for the first time (1831) the recommendation that domestic salt supplies should be iodized to prevent goitre. The circumstances are these. In 1824 von Humboldt 109 described the occurrence of goitre in the Andean plateau and referred to the striking fact that the inhabitants of goitrous localities recognized that salt from certain natural deposits was more beneficial than that from others. The following year, a young doctor named Roulin, 114 who had recently come to Colombia from Paris full of information and ideas about Coidet's new iodine treatment of goitre, 3 noted this and was instrumental in having samples of the salts analysed by Boussingault. On analysis Boussingault made the significant discovery that those salts instinctively preferred by the goitrous peoples contained most iodine. This prompted his recommendation.

Although almost 130 years have passed since Boussingault's advice was given, it is only recently that active steps have been taken to stamp out, by means of iodized salt, the serious degree of goitre which is still found throughout almost the whole length of the valleys of the Magdalena and Cauca rivers. The decision to introduce iodized salt has been taken as a result of several new and detailed goitre surveys.

The first of these inquiries, published by Socarrás 115 in 1942, showed that 10% of 153,000 prospective recruits for military service examined over a period of five years were rejected because of simple goitre. In January 1945, the Department of Nutrition of the Co-operative Health Service (Servicio Cooperativo Interamericano de Salud Pública) began a four-year survey of the geographical distribution and frequency of simple goitre among schoolchildren from 7 to 14 years of age throughout the entire country. Few, if any, more complete surveys of this kind have ever been made anywhere in the world. The results, published in summary form by Parra 111-113 and in great detail by Góngora y López, Young & Iregui, 107 are shown in Table III. They cover 183,243 children in 14 departments and show an average goitre rate of 52.62%, the highest figure being 81.14% for the Department of Caldas.

Commenting on this survey Parra 111, 112 mentions that the departments with the lowest goitre rates (Atlántico, Bolívar and Magdalena) border on the sea coast, where there is a higher consumption of foods of marine origin. He also refers to the fact that during the last thirty years simple goitre has been invading areas formerly untouched by it, e.g., the Departments of Caldas and Antioquia. This is because the regional supply of salt from iodized sources has gradually been almost completely replaced by cheaper salt of extremely low iodine content from large mines near Bogotá. Another interesting conclusion drawn from the survey is that in
TABLE III. PREVALENCE OF SIMPLE GOITRE AMONG COLOMBIAN SCHOOLCHILDREN, 1945-48

<table>
<thead>
<tr>
<th>Department</th>
<th>Children examined</th>
<th>Positive cases</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Antioquia</td>
<td>20,058</td>
<td>9,374</td>
<td>46.73</td>
</tr>
<tr>
<td>2. Atlántico</td>
<td>4,425</td>
<td>1,012</td>
<td>22.84</td>
</tr>
<tr>
<td>3. Bolivar</td>
<td>8,097</td>
<td>2,333</td>
<td>28.31</td>
</tr>
<tr>
<td>4. Boyacá</td>
<td>8,025</td>
<td>4,691</td>
<td>58.45</td>
</tr>
<tr>
<td>5. Caldas</td>
<td>25,280</td>
<td>20,511</td>
<td>81.14</td>
</tr>
<tr>
<td>6. Cauca</td>
<td>6,234</td>
<td>4,960</td>
<td>79.56</td>
</tr>
<tr>
<td>7. Cundinamarca</td>
<td>34,665</td>
<td>15,909</td>
<td>45.89</td>
</tr>
<tr>
<td>8. Magdalena</td>
<td>5,572</td>
<td>1,364</td>
<td>24.47</td>
</tr>
<tr>
<td>9. Huila</td>
<td>6,137</td>
<td>4,246</td>
<td>69.18</td>
</tr>
<tr>
<td>10. Nariño</td>
<td>12,892</td>
<td>4,844</td>
<td>37.57</td>
</tr>
<tr>
<td>11. Norte de Santander</td>
<td>4,130</td>
<td>1,684</td>
<td>40.77</td>
</tr>
<tr>
<td>12. Santander</td>
<td>10,523</td>
<td>4,993</td>
<td>47.45</td>
</tr>
<tr>
<td>13. Tolima</td>
<td>10,941</td>
<td>6,635</td>
<td>60.64</td>
</tr>
<tr>
<td>14. Valle del Cauca</td>
<td>26,264</td>
<td>13,879</td>
<td>52.84</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>183,243</strong></td>
<td><strong>96,435</strong></td>
<td><strong>52.62</strong></td>
</tr>
</tbody>
</table>

places with soft or semi-hard water the goitre incidence is less than in localities where the water is hard or very hard.

Where the endemic has been of long duration—100 years or more—the physique of the people is substandard and there are evidences of retarded mental development and of cretinism.

Goitre preventive measures involving the iodization of the salt supply for the entire country have been given official sanction, and Góngora y López & Young\(^{106}\) have given a full description of the approved process for iodizing the salt produced from the natural deposits found at Zipaquirá.

The average daily intake of salt per head is said to be 15 g, and the level of iodization adopted is 1 part of iodine in 25,000 parts of salt. That iodized salt is effective in reducing the degree of goitre in young Colombian children is already evident from the results of a two-year trial recorded by Góngora y López & Mejia.\(^{105}\) Beginning in May 1950, a total of 8,062 children from seven different localities in the Department of Caldas were given iodized salt regularly. As controls, 797 children from two other zones in Caldas and 1,648 children from the city of Bogotá were given no iodized salt. At a resurvey in April 1952 the number of cases of goitre in the iodized salt group had diminished by 57.6% compared with the rates obtaining in 1945-48. The goitre rate among the children not getting iodized salt was the same in 1952 as was found in the 1945-48 survey.
Among those who have made recent contributions to knowledge of Colombian goitre are Gomez-Afanador, who in a series of 244 cases found 82% to be simple goitres, 10% hypothyroid and 8% hyperthyroid; Thonnard-Neumann who refers to the goitre problem in his assessment of the poor nutritional status of the Colombian people; and Correa & Castro who describe the natural history of the disease in Cali.

Venezuela

From the Rio Magdalena in Colombia the goitre belt extends eastwards into Venezuela through the basins of the Meta and Apure rivers, and more particularly along the Cordillera of Mérida, affecting such places as Pamplona, La Grita, Tovar, Mérida, Trujillo and Barquisimeto, and continuing as far as Valencia and Caracas.

The most authoritative account of endemic goitre in Venezuela is contained in the comprehensive health survey of that country by Bengoa. He is of the opinion that goitre did not exist in Venezuela prior to the colonization, owing to the typical nomadic tendencies of the indigenous tribes of the Caribbean countries. When the people began to live in settled communities, however, goitre began to develop. Indeed, Bengoa refers to the tradition that from the time of colonization practically everybody in Trujillo was goitrous, a fact which in those days marked out foreigners and people without goitre as rare individuals.

The intensity of the goitre endemic in several towns of the Republic is seen in the following tabulation, which shows the percentage rates among students examined in the year 1941.

<table>
<thead>
<tr>
<th>Locality</th>
<th>Goitre rate (%)</th>
<th>Locality</th>
<th>Goitre rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>La Grita</td>
<td>47</td>
<td>Pregonero</td>
<td>12</td>
</tr>
<tr>
<td>Guarico</td>
<td>28</td>
<td>Cuicas</td>
<td>11</td>
</tr>
<tr>
<td>Monte Carmelo</td>
<td>25</td>
<td>Tovar</td>
<td>5</td>
</tr>
<tr>
<td>Chejende</td>
<td>18</td>
<td>Carvajal</td>
<td>2</td>
</tr>
<tr>
<td>Mérida</td>
<td>13</td>
<td>Campo Ellis</td>
<td>2</td>
</tr>
<tr>
<td>Biscucuy</td>
<td>12</td>
<td>Mucuchies</td>
<td>1</td>
</tr>
</tbody>
</table>

These rates are for cases of obvious goitre. Bengoa, from whose book the data are taken, says that only isolated cases of cretinism and deaf-mutism are encountered, and that the goitre problem in Venezuela as a whole does not have the same serious social significance as in some other South American countries. Nevertheless, he commends it to the notice of official public health authorities, with the proposal that iodized salt should be introduced to diminish the present intensity of the condition.

Heedful of this red light, the Instituto Nacional de Nutrición organized a series of field surveys and laboratory studies in 1951 which confirmed the high goitre rates existing along the Venezuelan Andes and foothills from San Cristóbal at the southern end of the ridge through Trujillo,
Tocuyo and the Carabobo area almost as far as the non-goitrous zone of Caracas. For instance, in the county of Bailadores in the state of Mérida 84.5% of 718 adults and 83% of 641 schoolchildren examined by Roche et al.\textsuperscript{124, 125} were found to have abnormally palpable thyroids. García\textsuperscript{122} encountered rates of between 22% and 96% among groups of men, women and children from different localities in Palmira and Piñango, two districts situated in the mountainous region to the north-east of Mérida between the states of Zulia and Trujillo. In Manuare valley (Carabobo state) Rodríguez\textsuperscript{126, 129} records an incidence of 36.3% in the 381 persons he examined, almost 16% of the total population of the district.

Radioiodine clearance has been studied by Roche and his colleagues on the inhabitants of the mountainous regions of Bailadores and Tabay in the far-west of the country and on goitre subjects from Manuare and San Joaquin in the state of Carabobo,\textsuperscript{118-121, 126, 127}

Some 500 miles to the south-east, Roche\textsuperscript{123} made similar investigations in the savanna of Kakuri near the sources of the Venturai river in the Amazon territory of Venezuela. Here, the 24-hour thyroidal uptake of \textsuperscript{131}I was measured in 53 well-nourished Indians who had had little or no contact with white men and who, with one exception, had thyroids that were either non-palpable or normal in size. The average \textsuperscript{131}I uptake was 70.8% of the administered dose; 45 of the cases had uptakes of more than 50% of the dose. Uptakes of six controls, members of the expedition, were within normal limits. If it be assumed that the demonstrated thyroidal avidity for iodine signifies iodine deficiency, the findings would suggest that such deficiency may exist without giving rise to the symptom of goitre.

**Ecuador**

From Colombia, the South American goitre zone passes southwards along the Cordillera into Ecuador, touching such centres as Quito, Cuenca and Loja.

More than 120 years ago, von Humboldt (1824)\textsuperscript{109} and Boussingault (1833)\textsuperscript{101} mention goitre as being endemic in Ecuador. In Llano Anciso a case was seen in which the swelling was 14 inches (36 cm) long and 8 inches (20 cm) across. Although this is exceptional, conditions predispose to the appearance of such phenomena. There are one or two areas, however, where goitre does not occur because the local sources of food salt are sufficiently rich in iodine.

In recent years the Ecuadorean goitre problem has been carefully studied by Sánchez & Paredes\textsuperscript{132} and by Arcos.\textsuperscript{130} Sánchez & Paredes state that most goitre is found in the central Andean spine running lengthwise through the middle of the country. The littoral zone to the west and the upper Amazonian area on the east side—both of which are comparatively low-lying—are less affected. These authors claim that the native Indians
and half-castes are most vulnerable to the disease because of their extreme poverty and poor nutritional status. This coincides with the opinion of Arcos, who maintains that goitre persists in the rural areas of Ecuador, particularly in the narrow Andean valleys, owing to low standards of living and the lack of adequate medical and social services. Arcos confirms that the disease is very extensive in the Province of Cotopaxi (formerly called Léon), especially among Indian races. He thinks, too, that thyroid deficiency is the greatest single cause of decadence among these peoples.

Precise statistics are not available in respect of the Ecuadorian population; but it is believed that goitre affects both sexes equally. It is particularly evident at puberty and adolescence. Thyroid enlargement is also known to occur among domestic animals in Ecuador (Sánchez & Paredes 132). Horses, pigs and lambs are affected.

An exhaustive review of the history and folklore of endemic goitre in Ecuador is given by León.131 He refers to the occurrence of the disease in the times of the Inca Empire, when it was known by the Quichua term cotto or coto meaning a mound or protuberance, and traces its development during and after the Spanish colonial era. The frequency of goitre throughout the Ecuadorian highlands has not only had its repercussions on the medical, biological and social life of the people, but has also influenced the national plastic and pictorial arts.

Peru

Although goitre, cretinism and deaf-mutism have long been a burden on public health in Peru, only recently have medical officials been able to convince the Government of the preventive possibilities in iodized salt and the need to make its use compulsory. The Ministry of Public Health in Peru has now organized a campaign for the prophylaxis of endemic goitre by means of salt iodized at the rate of 1 part of iodine in 10 000 parts of salt.

The location and intensity of the present-day endemic in Peru was first clearly defined by Salazar148 in a series of maps, on which occurrence is plotted department by department. Most affected are those departments covering the central higher parts of the country. Moving from north to south, the following are the ten departments with the highest rates: Amazonas (28.79%), Cajamarca (3.63%), Libertad (6.38%), Ancash (14.36%), Huánuco (19.96%), Junin (5.09%), Huancavelica (8.77%), Ayacucho (4.28%), Apurímac (9.88%) and Cuzco (4.92%). Cases of goitre in the remaining 13 departments of the country occur in 2% of the population or less.

Burga,134, 135 who is in charge of the Peruvian goitre campaign, has drawn special attention to the differences between goitre conditions in different parts of the Department of Amazonas. There, the goitre rate in low-lying areas—namely, 90%—is much greater than in the higher parts of the Department, and cretinism, mental deficiency and deaf-mutism are
correspondingly serious. The drinking-water is from streams. In the
highlands, on the other hand, Burga found a rate of 30%, mostly among
adolescents. Here the water-supply comes from wells. Goitre in newborn
babies is common, and the disease is also seen in domestic animals, par-
ticularly dogs.

In later and more comprehensive surveys covering the whole of Peru,
Burga has confirmed his earlier opinions, namely, that serious endemic
goitre is confined to the region of the Sierra, that it is not found on the coast,
and that in the rising and foothill country between these two zones the
disease has an intermediate severity, being wholly absent in some localities.

Burga's studies relating prevalence to altitude are among the best in the
goitre literature. Moving inwards from the coast to an ascent of the Cor-
dillera one first encounters cases of goitre at 250-850 metres above sea-level;
at an elevation of 1000-3000 metres the frequency increases, attaining average
rates of 15% to 25% and above. At this level, the disease is characterized
by the presence of cretinism, myxoedema, and a general state of hypo-
metabolism extending also to domestic animals. At an even greater height,
over 3300 metres, the goitre rate tends to diminish again, until it recedes
to an almost insignificant figure in places of highest altitude. In these
zones, cretins and cases of myxoedema are rarely seen and it is difficult to
find any animals with thyroid enlargement. These conclusions of Burga
and his team are based on the examination of many thousands of
men, women and children in 84 provinces of 14 districts of Peru.

A feature mentioned by Monge is the unusually large size of the
goitres found in Urubamba Province near the town of Cuzco in the southern
part of Peru. It appears, too, that toxic goitre (Basedow's syndrome) is
not uncommon in this area.

Those interested in historical aspects of goitre in Peru are commended
to the writings of Lastres and of Greenwald & Lastres.

Bolivia

Our knowledge of the distribution of goitre in Bolivia is due, in the main,
to the modern investigations of Balcazar, Fernández, and Ibáñez.

As with other South American republics, records of the Bolivian endemic
are several centuries old. Following the Spanish conquest of the Incas early
in the sixteenth century and the reorganization of the country as a depend-
cy of the Viceroyalty of Peru, known politically as the Audiencia of
Charcas, Viceroy Francisco de Toledo (1569-1581) sent a commission of
"empiricists" from his seat of government at Sucre to Zudáñez, capital of
the province of the same name in the Department of Chuquisaca, to cure
the goitre there, so serious had it become.

Significant, too, is the fact that the Bolivian word for goitre, "coto",
has given rise to the place-name Cotoca, a township in Cercado Province,
Department of Santa Cruz, in the east of the country. Similarly, in Tacuarembo and in Tarija, where goitres are very abundant, the words "cotudos" and "cotos" are in common use to describe the peoples there. (See also León \textsuperscript{131} under Ecuador.)

Worthy perhaps of passing mention is the local belief in certain places in Bolivia that goitre co-exists with an abundance of alder trees which, so it is conjectured, absorb all iodine from the soil and render it iodine-deficient.

Exact numerical statistics are not available but, from his personal observations, Balcazar has assigned the following degrees of prevalence to eight of the nine departments of the country, arranged in order as nearly as possible from north to south. He says that over-all rates of 40\% or more are not uncommon in some provinces.

\textit{Beni.} Very abundant, especially in the Provinces of Cercado and Vaca Diez, and in parts of Itéñez.

\textit{Santa Cruz.} Abundant. A rate of 17\% among schoolchildren in the capital city. Many cases in the Provinces of Valle Grande, Chiquitos and Cordillera.

\textit{La Paz.} Low incidence in the Yungas Provinces, but very prevalent in practically all the others. Very common in the peninsula of Copacabana (Lake Titicaca).

\textit{Cochabamba.} Frequent in many provinces. Abundant in Independencia, the capital of Ayopaya Province. Grave foci in Pasorapa, Toyota and Emereque.

\textit{Oruro.} Sporadic cases in several cantons.

\textit{Potosí.} An extraordinary number in Millares. Many cases in Tacabamba, Ancoma and Potobamba. Grave foci in Condes and frequent cases in many other places.

\textit{Chuquisaca.} Zudáñez Province is wholly goitrous. Many other places affected.

\textit{Tarija.} Very prevalent. Main foci are in the capital and in the Provinces of Cercado, Méndez, Avilés, Arce and O'Connor.

The goitre problem in Bolivia is bound up with lack of education, poor housing, deficient nutrition, generally low standards of living and the prevalence of venereal disease, alcoholism and indulgence in coca.

The Bolivian Government plan to iodize all food salt used throughout the country and to ensure this end propose to create a salt monopoly.

\section*{Chile}

Compared with other South American republics, Chile is not a goitrous country. During his travels from Argentina over the Andes into and throughout Chile in the years 1820 and 1821, Schmidtmeyer\textsuperscript{163} especially noted that "the inhabitants of Santiago, however, do not exhibit the same
enlargement of the neck and head as the Mendozines: . . . I observed it in women inhabiting cottages within a few leagues of Santiago, and in the midst of irrigated grounds, but nowhere else in Chile during a journey of above a thousand miles, along both the sea shore and the foot of the Andes." Strain also came across only a few isolated cases on his journeys through Chile in 1849; he was told by the people whom he met that goitre was unknown in Chile until about 20 years before that time, when, according to tradition, the disease made its appearance simultaneously with the introduction of the Italian poplar tree from Mendoza. Gilliss, another traveller, writes in much the same sense.

On the other hand, there are those who believe that the disease prevailed to a considerable extent in the colonial era, but has largely declined with improved conditions and the advance of time. Romero says that in Santiago during the sixteenth century a connexion existed between the prevalence of goitre among the aristocracy and the fact that they had their own private sources of highly purified drinking-water, whereas the poorer people obtained water from relatively impure public supplies. Fashionable painters of the time performed marvels in disguise the goitres of ladies who commissioned them to paint their portraits; elegance decreed the use of ribbons of black velvet around the neck and other aids to concealment. Some men, less concerned perhaps, allowed an unaesthetic and considerable tumour to show above the neckerchief.

Places considered to be mildly goitrous today lie in the area watered by the Aconcagua river, particularly around Los Andes and San Felipe. P. Martini (cited by Romero) of Los Andes mentions having seen goitre on the mountain road through the Cordillera to Juncal in Argentina. Feferholtz & Ortiz say that goitre is especially prevalent in Boco near Quillota, which is to the north-east of Valparaiso.

Farther south, cases are occasionally found along the valleys of the Maipo and Cachapoal rivers, and at La Punta, a settlement just north of Rancagua in O'Higgins Province (Cabello & Zúñiga; Zúñiga). In this neighbourhood, also, goitre has been noted at Doñihue. At Teno near Curico, Alvarez records a series of 111 cases, of which only 2 were men. He also observed a number of cretins and dwarfs. There are no established foci of endemic goitre in the Concepción area. Suazo Figueroa examined the reports of nearly 2500 biopsies and autopsies and found indications of the disease in only 45 persons (i.e., 1.8%), of whom 8 were men.

The most recent and most comprehensive surveys are those carried out by Donoso and his colleagues on 39,433 schoolchildren distributed over 287 schools in the six departments of the Province of Santiago, and on 8332 pupils belonging to 119 schools in the six departments of the Province of Coquimbo. The over-all goitre rate in these two provinces is 10%-11%; but, as Table IV shows, rates of 20%, 30% and nearly 40% are the rule in some districts.
<table>
<thead>
<tr>
<th>Department and district</th>
<th>Percentage with enlarged thyroid</th>
<th>Department and district</th>
<th>Percentage with enlarged thyroid</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Province of Santiago</strong></td>
<td></td>
<td><strong>Talagante</strong></td>
<td></td>
</tr>
<tr>
<td>Lampa</td>
<td>22</td>
<td>Isla de Maipo</td>
<td>15</td>
</tr>
<tr>
<td>Til-Til</td>
<td>25</td>
<td>Talagante</td>
<td>13</td>
</tr>
<tr>
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<td>El Monte</td>
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<td>Barrancas</td>
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<td>San Pedro</td>
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<tr>
<td>Santiago</td>
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<td></td>
<td></td>
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<tr>
<td><strong>Province of Coquimbo</strong></td>
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<td><strong>Ovalle</strong></td>
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<td>2</td>
<td>Illapel</td>
<td>17</td>
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<td>Andacollo</td>
<td>21</td>
<td>Salamanca</td>
<td>38</td>
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<tr>
<td></td>
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<td>Los Vilos</td>
<td>9</td>
</tr>
</tbody>
</table>
Other interesting Chilean contributions to goitre knowledge are those by Covarrubias,\textsuperscript{152} who writes on the relation between the thyroid gland and pregnancy, and by Cid Krebs\textsuperscript{153} and Oberhauser Bund & Cid Krebs,\textsuperscript{161} who have studied the iodine content of soils and waters in relation to goitre prevalence in the Province of Santiago.

**Argentina**

Nowhere in the west of South America is goitre more widely diffused than in those provinces and territories of the Argentine Republic bordering the eastern slope of the Cordillera—namely (from north to south), Jujuy, Salta, Tucumán, Catamarca, La Rioja, San Juan, Mendoza, Neuquén, Río Negro, and Chubut. In this great 1500-mile strip of territory goitre has been known since the Spanish conquest and it is of interest that one of the earliest and most impressive appeals for official intervention to deal with the menace relates to this area. Writing of Mendoza Province in 1820 Schmidtmeyer\textsuperscript{189} says:

The greatest number of the inhabitants of this state are afflicted with that unseemly and injurious disorder, the goitre, which prevails in so many parts of the world, and for the prevention of which little progress seems to have hitherto been made: yet the disease is such, as may justify an appeal to governments as well as to individuals, for farther and if possible more effectual efforts, for the discovery of its cause, and for the means gradually to remove it. It cannot be supposed, that Providence should have destined so many countries of the earth permanently to produce this evil, and the numerous inhabitants compelled to reside in them, to be for ever subject to it: mental or bodily faculties are generally more or less affected by it, and those who have been in the valleys of Swisserland [sic] and Savoy know, how often they are lost by this severe visitation, which, however, can only be viewed as one of the very many imperfections which meet us at every step, and are intended to draw forth our labours and our exertions for their removal.

Towards the centre of the country goitre is endemic in the Provinces of San Luis and Córdoba; and a very high prevalence is found in the Territory of Formosa and the Provinces of Corrientes and Misiones, all of which are eastern areas adjoining Paraguay, Brazil and/or Uruguay.

The precise rates in the various provinces and territories are not known; but some idea of the intensity may be gathered from surveys which have been carried out from time to time, particularly on schoolchildren. Thus, in some departments of Jujuy a goitre rate of 100\% was observed by E. Sola (cited by De Salas & Amato\textsuperscript{179}) in 1931. Later (1938), Lobo et al.\textsuperscript{173} encountered 77 goitres in every 100 schoolchildren in the area of San Pedrito. Salta is no less goitrous. An examination of 1278 schoolchildren by Lewis\textsuperscript{179} in 1924 revealed 87\% in boys and 88\% in girls. Lobo et al. found from 15\% to 45\% in Salta schools examined in 1938, and Oñativia\textsuperscript{180} has described goitrous cretinism in the Province as recently as 1959. In Tucumán rates of 65\% in boys and 60\% in girls have been recorded by Lewis, and the 1938 survey (Lobo et al.\textsuperscript{173}) disclosed an average rate of
23% for the whole province, with a maximum figure of 33.5% in Chiqui-
gasta. Statistics (1939-45)\textsuperscript{171} for Catamarca record a rate of 100% in a
school at Andalgalá; and Lobo and his colleagues found 32.68% of goitre
in 1500 children examined in La Rioja schools.

According to a 1937 census of schools in 16 different places in Men-
doza,\textsuperscript{170} goitre rates varied from 28% to 88% among young children, the
average rate being 43.5%. In subsequent studies, Perinetti and collabora-
tors\textsuperscript{185, 186} found 24,150 cases of thyroid enlargement among 52,548 children
examined (i.e., 46%). Of these, 60% were palpable goitres, 36% visible,
and 4% nodular. Data of a similar kind are available for the Territory
of Formosa and the Provinces of Corrientes and Misiones, in all of which
goitre frequencies of the order of 50% and above are found among children
of school age.\textsuperscript{167, 181, 182, 150}

Analytical researches by Mazzocco and Arias Aranda,\textsuperscript{177, 178} and by
De Salas & Amato,\textsuperscript{170} prove that goitre in Argentina is definitely traceable
to iodine deficiency in the waters, soils and foods of the affected districts.
An iodine therapy campaign was launched in the northern provinces of
Argentina in 1924 and again in 1938, control being exercised through
physicians and teachers. Tablets containing 5 mg of iodine were distributed
by the Public Health Service and iodized sweets were also used. Excellent
results were obtained, but on the basis of this experience it was decided that
if tablets are adopted as the prophylactic vehicle, it is preferable to issue
them in 10-mg iodine strength. These may be given with safety even to
quite small children. No cases of intolerance were encountered.

The Argentine Government is now tackling the goitre problem on a
broader basis, and strong moves are being made towards the general
introduction of iodized salt in all the seriously affected zones. Indeed, a
law has already been passed making this practice compulsory in the Pro-
vince of Mendoza.

Official concern is also reflected in the foundation of a Goitre Institute
in the Faculty of Medicine at the University of Cuyo, Mendoza, under
the direction of Dr. H. Perinetti. Here, important field and laboratory
studies of iodine-deficiency goitre have been carried out by Argentinian
scientists, in collaboration with a team of experts from the famous Boston
school of thyroidologists. The expedition, led by Dr. J. B. Stanbury of the
thyroid clinic of the Massachusetts General Hospital, demonstrated by
means of radioactive iodine the great avidity of the thyroid of goitrous
Argentinian patients for artificially administered iodine.\textsuperscript{191-193} This uptake
is related to the degree of iodine deficiency and is inversely proportional
to the amount of iodine excreted in the urine. Attention was focused
mainly on people below the age of 35 years, all of whom had goitres; usually
these were diffuse, but a few were multinodular and of great size.

Goitre literature pertaining to Argentina is extensive. In addition to
the sources already cited, papers by the following authors have been con-
sulted in preparing the foregoing summary: Bustos,168 De La Barrera,169 Maccarini,174-176 Olascoaga,179 Perinetti,183, 184 Romero,187 and Schiavone.188

Paraguay

Goitre is extensive in the mountainous districts of Paraguay and has been a public health problem for many years. It is recorded by Burton194 that at one time there was goitre in almost every home in Asunción. A reference in Schmidtmeier's journal189 suggests that the disease has been known in Paraguay at least since 1820.

Under the auspices of the Servicio Cooperativo Interamericano de Salud Pública, the present frequency of goitre in Paraguay has been determined from a study of recent hospital statistics and by the clinical examination of more than 44,000 children between the ages of 6 and 16 years in towns covering the most densely populated areas of the country.195, 197, 198

Peña197 and Isasi Fleitas,195 the two doctors chiefly responsible, found an average rate of 23.5% among children, the frequency in girls being four times that in boys. Children of families in comfortable circumstances were less affected than those from working-class homes. The hospital records show that the great majority of persons admitted for operative treatment were between the ages of 16 and 45 years.

In view of the prevalence of goitre more or less throughout the whole country, and the frequency of complications such as myxoedema and cretinism, iodized salt is officially recommended not only for children and pregnant women, but also for domestic animals in the endemic zone. During the three years 1946-48, tablets of Oridine, each containing 10 mg of iodine, were administered to children in four schools at the rate of one tablet per head weekly for about 20 weeks in each year. Before treatment the goitre rate was 26.1%; at the end of the first year's treatment it was 16.7%; by the end of the second year it had fallen to 8.2% and at the end of the third year it was down to 4.8%.195

Uruguay

A searching inquiry in 1935 led Pérez Fontana, Bennati & Volonterio203 to conclude that goitre is not seriously endemic in Uruguay. Subsequent studies by Proto204 and by Bauzá199 and Bauzá, Cerviño & Salveraglio209,201 suggest, however, that certain areas are suspect and that the existence of a mildly goitrous zone must be acknowledged in the Departments of Salto, Tacuarembó and Rivera towards the north of the country. Among school-children, Bauzá et al.201 found visible goitres to the extent of 6% in Salto and 17% in Rivera; among older students, the proportion was 5.9% in Salto and 14% in Rivera.

Elsewhere, sporadic occurrences have been noted in various places: for example, in the Departments of Lavalleja, Rocha and Cerro Largo to
the east and north-east of the country, and in the Department of Colonia on the west side. In the capital, Montevideo, situated on the south coast of the country, goitre does not occur.  

Thyroid enlargement accompanied by mental retardation among children in certain schools in the Department of Rivera (e.g., at Sauzal) has obliged the local education authorities to prolong the period of a child's attendance at school.

There does not appear to be any absolute deficiency of iodine in the soils and waters of Uruguay. Likewise, the thyroid glands of human subjects, cattle and dogs, examined post mortem, show a normal iodine content. It seems, therefore, that the cause of goitre in Uruguay must be sought in some goitrogenic factor in food which is responsible for creating a relative deficiency of iodine.

Determinations of the calcium content of normal and pathological human thyroid glands by Pérez Fontana and his colleagues showed that hyperthyroid glands had a low calcium content, whereas the calcium in hypothyroid glands was considerably augmented. There were insufficient data to establish a correlation between the amount of calcium in drinking-water and foods and the content of calcium in the thyroid.

Brazil

Endemic goitre is a problem of exceptional gravity in parts of Brazil. Pinotti estimates that no less than 11 640 000 people in a total population of approximately 62 000 000 are affected. The disease is particularly rampant in the southern States of Rio Grande, Santa Catarina, Paraná and São Paulo, the south-eastern States of Rio de Janeiro and Minas Gerais, and the great central and western States of Goiás and Mato Grosso. In the north and north-eastern parts of the country, goitre is perhaps less noticeable; even so, the intensity in Maranhão and Piauí is considerable (11%) and there is a prevalence of around 9% in the vast territory of Amazonas and Rio Branco.

Pinotti's summary is given in Table V.

Goiás and Mato Grosso.

Towns especially affected with goitre in the interior of these states are Natividade, Conceição, Arrayás, Goiás, Goiânia, and Cuiabá in the far west. Silva & Borges examined about half the children and young students regularly attending public and private educational establishments in the urban and rural zones of Cuiabá, Goiânia and Goiás—in all, 6803 persons of ages ranging from 7 to 21 years. The prevalence was very high in all three zones, being 72% in Cuiabá, 66.6% in Goiânia and 81% in Goiás. The rates were higher among coloured than among white children, in girls than in boys, in the country than in the towns, in public than in private schools, and in lower than in upper economic groups.
TABLE V. PREVALENCE OF GOITRE IN VARIOUS REGIONS OF BRAZIL

<table>
<thead>
<tr>
<th>Region and population</th>
<th>Percentage with goitre</th>
<th>Total number affected</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Central: 2 200 000</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mato Grosso</td>
<td>53.8</td>
<td>1 150 000</td>
</tr>
<tr>
<td>Goiás</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>South: 20 000 000</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>São Paulo</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paraná</td>
<td>27.7</td>
<td>5 500 000</td>
</tr>
<tr>
<td>Santa Catarina</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rio Grande do Sul</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>South-East: 16 000 000</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Minas Gerais</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Espírito Santo</td>
<td>27.0</td>
<td>4 300 000</td>
</tr>
<tr>
<td>Rio de Janeiro</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>East: 6 500 000</strong></td>
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<td></td>
</tr>
<tr>
<td>Sergipe</td>
<td>0.9</td>
<td>60 000</td>
</tr>
<tr>
<td>Bahia</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>North: 2 300 000</strong></td>
<td></td>
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</tr>
<tr>
<td>Amazonas</td>
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<td></td>
</tr>
<tr>
<td>Pará</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rio Branco</td>
<td>9.4</td>
<td>210 000</td>
</tr>
<tr>
<td>Amapá</td>
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<tr>
<td>Rondônia</td>
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<tr>
<td><strong>North-East: 15 100 000</strong></td>
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<td></td>
</tr>
<tr>
<td>Maranhão</td>
<td>11.8</td>
<td>350 000</td>
</tr>
<tr>
<td>Piauí</td>
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<td></td>
</tr>
<tr>
<td>Ceará</td>
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<td></td>
</tr>
<tr>
<td>Rio Grande do Norte</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paraíba</td>
<td>0.6</td>
<td>70 000</td>
</tr>
<tr>
<td>Pernambuco</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alagoas</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total: 62 100 000</strong></td>
<td></td>
<td>11 640 000</td>
</tr>
</tbody>
</table>

*São Paulo*

An extensive study of endemic goitre among infants, schoolchildren and college students in different parts of the State of São Paulo has been made by Dr Arruda Sampaio. Between 1940 and 1947 he examined more than 22 000 individuals and found rates of from 5% to 10% in littoral
districts, gradually increasing as he passed up through the valley of the Parahíba river into the highlands of the interior, where rates of 60%, 70% and even 90% were encountered along the Serra da Mantiqueira, which dominates the hinterland between the towns of São Paulo and Rio de Janeiro.

Goitre here is of the simple type. Its prevalence increases with age in zones which have an average or low proportion, being about 20% higher in children between the ages of 12 and 15 years than in those between 8 and 10 years. In heavily affected zones the goitre rate reaches a maximum even at pre-school age. Arruda Sampaio mentions foci of endemic cretinism in the areas of his study and also refers to a case of almost total colour-blindness in a goitrous patient which successfully responded to iodine treatment.

Another considerable goitre centre in São Paulo lies 50 to 100 miles north-west of the capital and comprises the inland towns of Campinas, Botucatu, Pirambóia and Anhelim. Here, a goitre inquiry has been made by Dr A. Lyra and Dr A. de Melo e Albuquerque on behalf of the Diretoria do Serviço do Interior. They examined 850 boys and 712 girls from 5 schools in this region and found an average rate of 38.58% among boys and 44.80% among girls. In a later publication, De Melo e Albuquerque refers to a rate of 70.6% among 3030 children examined by him at Campinas.

Paraná, Santa Catarina and Rio Grande do Sul

More than twenty years ago Duarte Nunes reported that physical incapacity due to thyroid insufficiency was of frequent occurrence among army recruits examined by him in the military hospital at Curitiba. Men with goitres were indolent, lazy and easily tired. After physical effort, tremor of the limbs was a marked feature. For these reasons Duarte Nunes recommended that anyone suffering from goitre be excluded from the Brazilian army.

This matter has recently (1955) been re-examined in great detail by Paes de Oliveira et al. Inspection of more than 120,000 young men of military age (19-20 years) drawn from nearly 200 municipalities in the States of Paraná, Santa Catarina and Rio Grande do Sul revealed that from 50% to 80% of recruits were rejected for service on account of ill-health and physical disability. Among the causes of rejection goitre stands high, rates of 25% being common in the upland areas of southern Brazil.

Minas Gerais

The goitrous districts of Minas Gerais lie from 100 to 200 miles due north of Rio de Janeiro at Barbacena, Ouro Prêto, Sabará, Congonhas and Conselheiro Lafaiete. The endemic presents a complex of symptoms
similar to that described in other grossly affected areas—goitre, cretinism, deaf-mutism and mental debility. Chemical examination of the local water-supply and vegetable foods clearly proves that the country is deficient in iodine. The antithyroid effects of the commonly used foods in Minas Gerais have been examined by Lopes.\textsuperscript{224}

Dr Lobo Leite,\textsuperscript{220-223} who is the recognized goitre authority in this area, found an average rate of 44% in the town of Lafaiete (Queluz) and surrounding rural districts. With the co-operation of school officials he established a prophylactic centre for the purpose of distributing iodized chocolate to the schoolchildren twice a week. A rate of 44% at the beginning of the scheme in 1940 had by 1942 declined to 27%. These two years of iodine prophylaxis also had the effect of greatly improving the mental alertness of the children. Many obtained higher marks and a larger number were promoted than before the iodine treatment was introduced. The preventive dose was ten times greater than the calculated need, but there were no harmful results.

Additional evidence of the goitre rate among the general population in Minas Gerais is provided by De Paula\textsuperscript{217} and also by Pinto Viegas,\textsuperscript{221} who found 252 records of thyroid disease among the case-sheets of 2500 miscellaneous patients in a doctor’s private practice—a rate of 10%.

\textit{Rio de Janeiro}

So great is the intensity of the endemic in the interior of the State of Rio de Janeiro that nearly all the inhabitants are affected and any person without goitre is regarded as abnormal. In 1944, out of every 1000 persons examined and treated by the Serviço de Endocrinologia e Policlinica General, there were 387 with disorders of the thyroid gland (Peregrino\textsuperscript{229}).

\textit{Amazonas and the North-East}

So far as we have been able to ascertain, no records of endemic goitre in the Amazon area existed before 1956. About that time Lowenstein\textsuperscript{225} became aware of the disease in the rubber-producing locality of Belterra, a community established by Henry Ford in 1934 south and slightly west of Santarém on a plateau overlooking the river Tapajoz, one of the largest southern tributaries of the Amazon river; it lies about 500 miles west of Belém. Here, in 1956, Lowenstein found dental caries and endemic goitre to be without doubt the main nutritional problems in a sample of 84 families (413 persons) he examined.

One year later, Lowenstein made follow-up visits to 75 of his original 84 families to find that owing to higher wages granted in the interim, and consequently affording improved nutritional conditions, goitre rates had markedly regressed. Nevertheless, a level of 10% to 20% is even now characteristic of this settlement.
Northern Europe

Iceland

Endemic goitre does not occur in any part of Iceland, nor has it ever been known to have occurred there; goitre in schoolchildren has never been detected and even sporadic cases of simple goitre are rare. But hyperthyroidism, including exophthalmic goitre, appears to be relatively frequent (Sigurjónsson). In short, whenever diffuse goitrous enlargement of the thyroid does occur in Iceland it is almost always accompanied by thyrotoxicosis. Thus, of 50 diffuse goitres examined by Sigurjónsson, 38 were associated with Graves-Basedow disease, 10 were cases of simple hyperthyroidism, and only 2 were considered to be without definite symptoms of thyrotoxicosis.

The absence of simple iodine-deficiency goitre in Iceland is undoubtedly due to the fact that the iodine intake of the population is high because of the large consumption of fish and fish products. This leads to an unusually high concentration of iodine in the thyroid and is the reason why in Iceland the human thyroid is exceptionally small.

In the adult Icelandic male the average thyroid weight is about 14 g and in the female, 11.6 g. This is about half the accepted normal weight (25 g) of the non-goitrous thyroid in other countries. Correspondingly, the average iodine content per gram of dry substance is 4.01 mg in glands from males and 3.43 mg in those from females. This is double the average iodine content (2 mg per gram of dry substance) of normal glands from other non-goitrous countries. It is clear, therefore, that the total amount of iodine in Icelandic thyroids is more or less the same as that found in normal thyroid glands elsewhere, namely, from 8 mg to 12 mg.

Finland

Wahlberg distinguishes four goitre belts in Finland, extending northwards from the coast of the Gulf of Finland into the central part of the country which has the most lakes. The most easterly of these belts starts in the neighbourhood of Viipuri and continues north-eastwards around Lake Ladoga and across the Karelian Isthmus. Farther west, the second belt runs northwards from Miehikkälä (St.-Michel) towards Jäppilä. The third region lies immediately east of Lake Päijänne and the fourth west of it, Lake Päijänne thus intervening between these two goitrous areas. There is a definite but not very severe endemic in Helsinki (Järvinen & Leikola) and a considerable number of cases occur on the Åland Islands (Lamberg et al.). Only the coast of the Gulf of Bothnia and the south-western part of the country lie outside the endemic zone.

On the basis of statistics obtained from the medical examination of military conscripts over a period of ten years, Wahlberg concludes that incidence depends on geological conditions. The above-mentioned four
belts of high frequency are in that part of the country which was not submerged at the end of the Ice Age—areas which, compared with others, have a higher calcium and lower iodine content of soils and waters.

The prevalence of goitre in Finland in relation to environmental iodine supply has been investigated by Adlercreutz,²³⁶,²³⁷ by Virtanen & Virtanen,²⁵⁵ by Vilkkii,²⁶⁴ and by Järvinen & Leikola.²⁴³ With the aid of radioactive iodine, Lamberg and his colleagues have carried out numerous metabolic and diagnostic studies in various endemic goitre areas of Finland.²⁴⁵-²⁴⁸,²⁶⁰ Adlercreutz analysed a total of 74 samples of water from 60 different places in Finland and reached the conclusion that, generally speaking, there is a positive correlation between the occurrence of goitre and a low iodine content of water. He found several exceptions, however, notably at Veteli, a town in the Department of Vaasa, where a water supply containing little iodine serves both a definite goitre area and its non-goitrous surroundings, and at Värtsila, where goitre is associated with a water of high iodine content. Likewise, the observations of Lamberg et al. are consistent with the concept that endemic goitre in Finland is due chiefly to iodine deficiency, although contributory factors, such as naturally occurring goitrogens and hereditary and constitutional defects, are also operative. Järvinen & Leikola touch upon the part played by abnormally high calcium and chlorine content of drinking water in the absence of sufficient iodine.

The daily iodine intake from food and the urinary iodine excretion of men, women and girls from goitrous and non-goitrous rural areas have been compared by A. I. Virtanen and E. Virtanen, thus:

<table>
<thead>
<tr>
<th></th>
<th>Goitrous area</th>
<th>Non-goitrous area</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>men</td>
<td>women</td>
</tr>
<tr>
<td>Total iodine in daily diet (µg)</td>
<td>53</td>
<td>56</td>
</tr>
<tr>
<td>Urinary iodine (µg per litre)</td>
<td>20.3</td>
<td>21.7</td>
</tr>
</tbody>
</table>

The recent study by Vilkkii²⁶⁴ deals with the iodine content of foods generally consumed in Finland and, in particular, with the iodine content of milk from two contrasted areas—namely, Turku, where the goitre rate is comparatively low, and Kuopio, where the rate is distinctly above the average for the country. Milk consumed in the Kuopio area, where goitre is prevalent, contains approximately 40% less iodine than milk from Turku, where the prevalence is low. The average iodine intake per person per day from all food sources is about 50 µg in the high-goitre area and about 70µg in the area of low prevalence. Thus, the mean iodine supply in Finland is considerably below the minimum level of 100 µg per head per day recommended by the World Health Organization.

On the question of the actual incidence of goitre in Finland, Wahlberg records that the endemic is responsible for 2000 operative cases annually out of a population of 3½ million. These account for 30 000 days of hospital attendance and give rise to numerous cases of chronic heart disease.
For the purpose of assessing the goitre situation in Finland, 1000 consecutive parturients and their 1015 children (15 twin pregnancies) were examined by Hiilesmaa in the First and Second Women's Clinics at the University of Helsinki. Enlarged thyroids were found in 141 of these 1000 women; but if one includes the cases in which nodules (adenomata) were detected in non-enlarged thyroids, then the percentage of abnormal thyroids in this series of mothers rises from 14.1 to 28.4, as the following tabulation shows:

<table>
<thead>
<tr>
<th></th>
<th>Number of cases</th>
<th>Number with nodules</th>
<th>Number without nodules</th>
</tr>
</thead>
<tbody>
<tr>
<td>With goitre</td>
<td>141</td>
<td>91</td>
<td>50</td>
</tr>
<tr>
<td>Without goitre</td>
<td>859</td>
<td>143</td>
<td>716</td>
</tr>
<tr>
<td>Total examined</td>
<td>1000</td>
<td>234</td>
<td>766</td>
</tr>
</tbody>
</table>

Of 1015 infants born to these 1000 women, 139 were found to have goitre.

The high proportion of cases with thyroid nodules is considered one of the chief characteristics of endemic goitre in Finland. Out of 952 cases of non-toxic simple goitre examined by Järvinen and Leikola at Helsinki University Third Medical Clinic and in the medical wards of Kivelä Hospital no less than 483 (51%) had one or more thyroid nodules, the smallest being pea-size.

Mortality from coronary disease among men is higher in Finland than in any other European country. Statistics suggest that cardiovascular symptoms are more prevalent in the eastern goitrous part of the country than in the western goitre-free areas. On post-mortem examination Uotila et al. found that goitre was commoner, and the average weight of the thyroid higher, in 250 persons who died of coronary sclerosis than in 250 persons who died from other causes. They conclude that goitre and arteriosclerosis may have a pathogenic relationship, possibly through hypothyroidism and the overproduction of thyroid-stimulating hormone by the pituitary gland. According to Roine et al. this parallelism between the geographical distribution of goitre and cardiovascular disease may be related to the significantly larger intake of iodine, ascorbic acid, and vitamin E in the non-goitrous west than in the goitrous east of the country.

Iodine deficiency in animals is frequently encountered in Finland. R. Moberg (personal communication, 1949) says that the deficiency is so acute in the Karkkila district that saucers containing alcoholic tincture of iodine are customarily placed under the rafters of stables and cow-houses—a practice that is claimed to yield especially good results in overcoming reproductive failures. Haaranen has compared the thyroid weights of pigs from north-east Finland, where goitre is prevalent, with those from comparable animals reared in a non-endemic coastal area. The former were more than double the weight of the latter. Peltola & Virtaainen were unable to prevent or alleviate thyroid enlargement in cattle from endemic areas and consider therefore that iodine deficiency in food is not the sole cause of goitre among animals in Finland.
Goitre prevention throughout the whole of Finland by means of iodized salt is strongly advocated by Wahlberg, Uotila & Turpeinen; but if this measure is not immediately practicable on such a large scale, it should certainly be applied at once in the most seriously affected areas—namely Tavastehus, Viipuri (Vyborg), St.-Michel and Kuopio. A comparison by Jussila of goitre rates among schoolchildren showed that the frequency had fallen markedly between 1928/29 and 1953/54 in areas where the standard of living had risen and in communities reached by propaganda for iodine prophylaxis. No change was seen in poorer districts with a low standard of living.

Sweden

According to Greenwald, the first report of goitre in Sweden dates from 1815 and refers to its endemicity in and around Falun in Kopparberg. Today the disease has a fairly widespread distribution clearly defined by the exhaustive studies of Höjer. From Västernorrland and the northern and eastern parts of Jämtland the goitre belt extends southwards through practically the whole of Gävleborg and all Kopparberg, except the north-western tip, into Värmland, Västmanland and the northern part of Östergötland. The southern goitre area extends from the Östergötland plain into the Counties of Jönköping, Kalmar and part of Kronoberg.

Goitre-free or almost goitre-free areas are the plains of Skåne, Halland and Västergötland, the district of Bohuslän and the plain of Dal, as well as the slopes of the tableland lying south-west of the city of Jönköping. The most northerly part of Norrland and the islands of Öland and Gotland in the Baltic are also goitre-free.

Höjer and his survey team examined 29,000 people in 180 different places and found that, in the most severely goitrous areas, the goitre rate averages about 25%; but that there are many places where 15% of the population are affected. They concluded that in all Sweden there must be not less than 300,000 people with goitre.

An interesting feature of Höjer’s investigation is the way in which he has been able to correlate goitre occurrence with the topographical lie of the land. His fullest account contains many explanatory sketches and diagrams showing the kind of terrain in which goitre is most likely to be found. Deep valleys with overhanging mountains, and areas at the foot of large slopes, are notorious goitre grounds. Plains and high plateaux are less affected.

In so far as Norrland rivers are concerned, Höjer confirms McCarrison’s thesis that goitre frequency gradually increases along a river valley as one passes from the source of the river to its mouth. These north Swedish rivers rise in goitre-free regions, pass through areas of sporadic occurrence and eventually flow into lands of considerable goitre intensity. In south Sweden, however, matters are quite the reverse. It is true that the Emån
river runs from end to end entirely through endemic goitre areas, but in the case of the Svartån and Stångån rivers, goitre is more prevalent in the upper reaches than in the lower. Similarly, rivers in the County of Blekinge, and those of Halland, flow from goitre areas into districts almost goitre-free.

According to Höjer’s observations, wherever the prevalence of human goitre in Sweden is high, say, from 15% to 30%, one may almost certainly expect to find goitre among domestic animals—horses, cows, sheep, dogs, and cats. Where goitre is of sporadic occurrence, Höjer occasionally saw domestic animals affected, but in goitre-free districts he never found any goitrous animals.

Toxic goitre is not unknown in Sweden. As might be expected, its distribution closely corresponds to that of simple endemic goitre (Sällström 267). This is in accord with experience in many other countries. As regards cretinism, Höjer found about one case among every hundred persons in districts where goitre is endemic. A special study carried out in southern Sweden on the extent of mental deficiency in districts with varying degrees of goitre shows that mental deficiency increases with increasing prevalence of goitre.

The iodine content of milk from various districts in Sweden has been determined by Sjöström.269 His results lend support to the iodine-deficiency theory of goitre causation. Sjöström 268 also determined the amount of iodine in water samples from sixty of Sweden’s major water works; in this instance, however, he did not correlate the resultant data with goitre prevalence.

Prevention of goitre by iodized salt is officially recommended in Sweden and instructions on how to obtain and use the salt have been circulated by the Royal Medical Department to all public health administrations and municipal medical officers.

Norway

The most goitrous districts of Norway are found in a belt extending from the interior of Telemark County north-eastward for about 120 miles into Hedmark County where the country around Lake Mjøsa is particularly affected. Long recognized as goitrous, this zone was surveyed by Johannesen 272 in 1891. He tried to relate goitre occurrence with geological conformation and mentions strong endemcity in the country surrounding Tyrifjord, Randsfjord and Mjøsafjord, and in such places as Lier, Modum, Ringerike and Toten.

Kjølastad,273 in a survey carried out in 1921, found a great deal of goitre among schoolchildren in towns in central Telemark. In some places the rate was 80%, 90% or even 100%. Typical percentages, for girls and boys respectively, were: Bø, 45 and 55; Sanda, 74 and 96; Brunkeberg, 38 and 25; Flatdal, 55 and 44; Krokan, 29 and 80; Sandnes, 56 and 42; Utbøen,
45 and 57. It is interesting that in several of these places the goitre rate was higher in boys than in girls; but the over-all figures for 537 girls and 510 boys in the Holla, Lunde, Bø, Seljord and Kviteeid areas were 57.5% in girls and 55.8% in boys.

Studies by Nicolaysen and by Lunde refer to goitre among schoolchildren in towns bordering the Oslo Fjord and in the neighbouring area of Sandsvaer just south of Kongsvinger. At Vittingfoss, for example, the rate was 55%, at Berg 38%, and at Komnes 40%. Considerably farther north, Nicolaysen found goitre in isolated districts throughout Gudbrandsdal in Opland and Østerdal in Hedmark.

On the west coast of Norway cretinism occurs in the area immediately north of Bergen and south of the Sogn Fjord (Skaar). North of the Sogn Fjord the prevalence in relation to environmental iodine supply has been studied by Iversen, Lunde & Wülfert. At the isolated village of Veitestrand in Sogn 70% of the 500 inhabitants were found to be goitrous. Not far distant, the district of Vik in Sogn is goitre-free.

More recently, Devold & Closs carried out a goitre survey in the district of Forsand near Stavanger. In this area goitre prevalence and thyroid size increased with distance from the sea, from 19.8% in men and 29.9% in women in the group nearest the sea to 35.9% in men and 62.8% in women in the group farthest up the valley. Noteworthy was the finding that consumption of fish by the people decreased as distance from the sea increased.

**Denmark**

The older literature repeatedly states that Denmark is free from endemic goitre. More recently, however, it has been shown that certain parts of the country have localized accumulations of goitre cases, not severe perhaps, but sufficiently noticeable to warrant medical attention and the need for preventive action. Thus, in 1933 Dalsgaard-Nielsen discovered a comparatively large number of goitres in Bedsted-Lø, a small parish in South Jutland lying between Aabenraa and Legum Kloster. On more closely examining 40 unselected goitres in this area he found that 23 were hyperthyroid, 6 were hypothyroid and 11 did not show any special characteristics.

The goitre problem in Denmark was subsequently elucidated more thoroughly in a comprehensive monograph by Rosenquist who investigated the endemic area along the river Gudenaa between Silkeborg and Randers, particularly the district at Gern and Svostrup. He compared the prevalence at these places with that in the goitre-free district of Snebjerg some 30 miles farther west. The percentage rates were as follows:

<table>
<thead>
<tr>
<th>Location</th>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Snebjerg (goitre-free)</td>
<td>0.8</td>
<td>5.5</td>
</tr>
<tr>
<td>Gern (goitrous)</td>
<td>5.7</td>
<td>18.4</td>
</tr>
<tr>
<td>Svostrup (goitrous)</td>
<td>12.2</td>
<td>30.2</td>
</tr>
</tbody>
</table>
In the two goitre districts (Gern and Svostrup) a total of 2433 persons were examined of whom 363, or 14.9%, were goitrous. Forty-six, or 12.7%, of these 363 goitrous people showed symptoms suggestive of toxic goitre.

Meulengracht\textsuperscript{287} and Iversen\textsuperscript{285, 286} have shown that thyrotoxicosis increased noticeably in Denmark during the Second World War. Meulengracht’s evidence, derived from records of hospital admissions, shows that a gradual rise in the number of cases of thyrotoxicosis during the period 1933-41 was followed by a sudden upward jump in 1942. The number of cases seen in his own clinic rose from 34 in 1941 to 118 in 1942. Meulengracht considered possible statistical fallacies in the returns, but concluded that both the steady rise between 1933 and 1941 and the abrupt increase in 1942 were real phenomena, though probably independent. He could not find any explanation for the rise; the 1942 “epidemic” could not be ascribed to the emotional disturbances of war, because in the histories of his patients he could find no abnormal occurrence of mental crises. Furthermore, there was apparently no corresponding increase in thyrotoxicosis in neighbouring countries involved in the war.

Iversen,\textsuperscript{285, 286} who greatly amplified and extended Meulengracht’s original observations and brought the matter up to 1947, confirms that the wartime increase in thyrotoxicosis in Denmark was a real one and not simply the result of better diagnosis. His figures relating to the city of Copenhagen are given in the tabulation below. They reveal a slow increase in incidence from 1938 to 1941, a sharp rise beginning in 1942 and reaching a peak in 1943-44, and a falling-off to 1947, when the rate was practically the same as in 1939-40.

<table>
<thead>
<tr>
<th>Year</th>
<th>Cases per 100,000 of population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1938</td>
<td>19</td>
</tr>
<tr>
<td>1939</td>
<td>23</td>
</tr>
<tr>
<td>1940</td>
<td>23</td>
</tr>
<tr>
<td>1941</td>
<td>34</td>
</tr>
<tr>
<td>1942</td>
<td>77</td>
</tr>
<tr>
<td>1943</td>
<td>84</td>
</tr>
<tr>
<td>1944</td>
<td>83</td>
</tr>
<tr>
<td>1945</td>
<td>52</td>
</tr>
<tr>
<td>1946</td>
<td>31</td>
</tr>
<tr>
<td>1947</td>
<td>21</td>
</tr>
</tbody>
</table>

The psychological effects of the German occupation are not held responsible for the sudden change in prevalence because the behaviour of the invaders during 1941, when the rise in thyrotoxicosis began, was comparatively mild and there was no further rise in 1944, when conditions became much more exacting. Moreover, during the same period, the incidence and severity of toxic goitre tended to decrease in Belgium and the Netherlands, while in Norway a small increase in incidence during the early stages of the German occupation was followed by a fall.
Iversen points out that wartime changes in diet may have played some part and in this connexion puts forward the following interesting theory, although without proof. Before the war large quantities of soya-bean-oil meal were imported into Denmark for feeding cattle. These imports were greatly reduced in 1940 and ceased entirely in 1941 and subsequent years. Soya bean is well known to contain an anti-thyroid factor which, when soya is normally used as cattle-feed, might find its way into cow's milk and thus supply the human population with sufficient anti-thyroid factor to keep down the incidence of thyrotoxicosis. If this were true, cases of thyrotoxicosis would tend to increase in number when, as in wartime, the supply of soya bean with its content of anti-thyroid factor was cut off.

These speculations find some support from what in fact were the very opposite experiences of Belgium during the war. Here, not only was there no increase in the absolute number of cases of toxic goitre, but the severity of existing cases appeared to decline. Side by side with this was an increase in the incidence of simple goitre. In explanation of these phenomena, Bastenie,282 who made the observations, points out that during the war the Belgian people tended to eat more and more vegetables of the Brassica genus—cabbage, kale and the like—which contain anti-thyroid substances. If the increased simple goitre in Belgium was in fact of the "cabbage" goitre type, then a reduction in severity might be expected in cases of toxic goitre on the same diet. The opposite effects might therefore be expected if anti-thyroid compounds were withdrawn from the diet. Such, it is postulated, was the case in Denmark during the war.

Estonian SSR, Latvian SSR and Lithuanian SSR

There does not appear to be much goitre in the former Baltic States. Adelheim's data for Estonian schoolchildren are quoted by McClenond and show a goitre rate of less than 0.5% in the four districts Hapsalu, Tallinn, Rakwere (Wesenberg) and Paide (Weissenstein). A later survey by Ucke confirmed that there is little goitre in Estonia.

Goitre occurs in some districts of Latvia. Here, the special morphological characteristics of the disease have been described by Ilinskii.259-291

The iodine content of Latvian waters in relation to the distribution of goitre has been studied by Kupzis.293, 294 In general, where the disease is known to be absent or infrequent, as at Kemer, Mitau, Silupe, Riga and the surrounding coastal districts, Liepaja in the west, and Wolmar in the north, waters contain between 2 μg and 15 μg of iodine per litre. In contrast, iodine contents of 0.1 μg to 2 μg are found in areas farther inland where goitre is of common occurrence—namely, Zesvaine, Madona and Priekule.

Theses by Justus and by Lewin, published in 1913 and 1928 respectively, refer to the occurrence of goitre in Königsberg (Kaliningrad) and other neighbouring towns in Lithuania and what was formerly East Prussia,²

² Now part of Poland
notably at Memel (Klaipeda), Braunsberg (Braniewo), Lyck (Elk), Allenstein (Olsztyn), Neidenburg (Nidzica) and Osterode (Ostroda). Prevalence was mild, being about 5.78% in girls and 3.08% in boys. Modern data on goitre in this territory are lacking.

Netherlands

The first reliable goitre statistics from the Netherlands were those of Brand, for whom the war of 1914-18 provided an opportunity to examine 46,975 mobilized servicemen from all parts of the country. He found that 10% of men from the Rhine-Maas area in the centre of the country had goitre, whereas only 1.4% of those from the Province of Groningen in the north were affected.

Subsequently (1924), the Central Board of Health of the Netherlands Government set up a special commission to study the goitre problem in greater detail and to advise on appropriate measures to remedy a situation which had apparently been getting gradually worse during the previous 25 years. This commission—composed of clinical men, chemists, pathologists, bacteriologists and other experts—reported in 1932 on the examination of 34,000 children and adults in schools and factories.

These new statistics for the most part confirmed Brand’s distribution data of 15 years earlier and, as a result, a very detailed goitre map of the Netherlands has been made. Broadly speaking, the eastern, central and southern parts of the country are prone to be goitrous, whereas the western and northern regions are almost free from the disease.

Immediately to the east of the Zuider Zee a considerable incidence has been found in such places as Wolvega, Steenwijk, Hoogeveen, Meppel and Kampen. At the south end of the Zee goitre occurs among the people of Harderwijk, Hilversum, Bussum, Naarden and Weesp. Towards the eastern frontier the incidence is liable to be high in Emmen, Koevorden, Almelo, Enschede, Diepenheim, Boekelo, Winterswijk, Aalten and Doetinchem. Centrally, high figures were found among schoolchildren in the Betuwe (“river” area) at Tiel, Wamel and Leeuwen, and at Hoven, Arnhem, Ede, Renkum and, particularly, Kuilenburg, Gorinchem, the Krimpen area and Breda. In the extreme south and south-east of the country the survey revealed goitre in Roermond, Eindhoven, Roosendaal and Bergen op Zoom; and on the western seaboard it has been found at Hillegom, Lisse, Sassenheim, Noordwijk and Warmond.

Places which are goitre-free, or have a negligible prevalence, are Assen and Groningen in the north, Zutphen in Gelderland, and Gouda and Barendrecht in the western part of the country. In a recent nutrition survey of Ijsselmonde, goitre was encountered occasionally by Kaayk.

An interesting study of goitre in the south-east corner of Friesland has been made by Pasma. He refers particularly to the municipality of Ooststellingwerf, where 40% of the children were found to have thyroid
enlargement. In the same area goitre is common at Weststellingwerf and among very young children at Wolvega. Pasma observed that the intellectual level of the affected children was much below that of children who were goitre-free. Conditions in south-east Friesland are in marked contrast to those in north-west Friesland, which is entirely non-goitrous.

As part of the work of the Goitre Commission, Dr J. F. Reith, of the State Institute of Public Health at Utrecht, carried out a large number of analytical studies which prove conclusively that deficiency of iodine in the drinking-water is the cause of goitre in the Netherlands. The inverse relationship between the goitre rate and the iodine content of drinking-water is clearly seen in the tabulation below, which shows the percentage of goitre found among schoolchildren in various towns and the content of iodine in the water.

<table>
<thead>
<tr>
<th>Goitre rate (%)</th>
<th>Iodine in water (µg per litre)</th>
<th>Goitre rate (%)</th>
<th>Iodine in water (µg per litre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hoogeveen</td>
<td>66</td>
<td>3.6</td>
<td>Harderwijk</td>
</tr>
<tr>
<td>Renkum</td>
<td>58</td>
<td>1.3</td>
<td>Doetinchem</td>
</tr>
<tr>
<td>Roosendaal</td>
<td>55</td>
<td>1.5</td>
<td>Kampen</td>
</tr>
<tr>
<td>Alemlo</td>
<td>53</td>
<td>3.0</td>
<td>Steenwijk</td>
</tr>
<tr>
<td>Gorinchem</td>
<td>52</td>
<td>3.0</td>
<td>Bergen op Zoom</td>
</tr>
<tr>
<td>Arnhem</td>
<td>50</td>
<td>1.0</td>
<td>Meppel</td>
</tr>
<tr>
<td>Kuilenburg</td>
<td>50</td>
<td>1.6</td>
<td>Zutphen</td>
</tr>
<tr>
<td>Ede</td>
<td>48</td>
<td>2.5</td>
<td>Gouda</td>
</tr>
<tr>
<td>Breda</td>
<td>47</td>
<td>1.7</td>
<td>Barendrecht</td>
</tr>
</tbody>
</table>

On the basis of their investigations the Goitre Commission reached the conclusion that, on an average, the daily intake of iodine from food and water was deficient by 80 µg per head of population. Accordingly they recommended that drinking-water in goitre regions should be fortified with potassium iodide so that each individual would receive approximately 80 µg of additional iodine per day. The per caput consumption of tap-water in prepared food and for drinking purposes was estimated to be 1.5 litres daily. It was therefore decided to raise the iodine content of tap-water by 50 µg per litre.

The iodizing installation used by the municipal water departments consisted of a glazed-stone mixing-vessel in which 100 litres of a 0.5% or 1% solution of potassium iodide were prepared. The addition of this stock solution to the main reservoir was achieved by means of a regulated dropping-needle, and the raised iodine content was checked by periodical analyses.

The Netherlands is the only country where goitre prophylaxis by iodized water has been successfully applied for any length of time on a large scale. In the hands of the Netherlands authorities the method has yielded results which compare favourably with those achieved in other countries by iodized salt. For example, at Kuilenburg a rate of 40% among children in 1931 had declined to 18% by 1937, to 14% by 1939 and to 4% by 1941.
Unhappily, plans to set up additional installations to supply iodine-rich tap-water throughout the country had to be abandoned on account of the 1939-45 war. Indeed, the Germans stopped this form of prophylaxis entirely and it has never been re-introduced. As an alternative, the public health authorities advocated that all salt used for making bread be iodized in those municipalities which had previously applied the iodized-water method of prophylaxis. Accordingly, a decree came into force in 1942 making it compulsory for bakers in those particular municipalities to use only iodized salt—the so-called “Jobrozo”. Writing in 1952, De Josselin de Jong\textsuperscript{301} states that Jobrozo (which contains 1 part of iodine in 33 000 parts of salt) is now used compulsorily for bread-making in 260 communities. Originally Jobrozo was somewhat more expensive than common salt; but the Royal Netherlands Salt Industry now produces it at the same cost. The results of this method of preventing goitre in the Netherlands have recently been described by Hipsley,\textsuperscript{303} who has introduced the method in Australia.

While officially controlled prophylaxis, first with iodized tap-water and later with bread salt, was gradually being applied town by town, a lively public awareness of the goitre problem became evident, and places not at once covered by the official measures began to introduce various uncontrolled prophylactic procedures of their own. To regularize these independent activities the Royal Netherlands Salt Industry put on the market an iodized salt, called “Jozo”, for general use. This contains 1 part of potassium iodide in 200 000 parts of salt, and between 1932 and 1951 its production rose from 520 000 kg to 10 million kg.

All the most up-to-date information on endemic goitre in the Netherlands, including the results of preventive measures, has been brought together recently (1959) in a comprehensive volume published by the Organization for Health Research under the authorship of Pasma, Terpstra, de Wijn, Kroes, & Langeveld.\textsuperscript{303} The main conclusions from this remarkable survey deserve brief mention.

Examination of large numbers of schoolchildren from all over the country shows that, apart from municipalities where iodine prophylaxis has brought about a decrease in goitre rates, only a few localities are goitre-free, namely, Zutphen, Gouda, Amersfoort, 's-Hertogenbosch, Barendrecht and Moordrecht. It is stated that in these places absence of goitre is due to the fact that there is a sufficiently high iodine content in the tap water, the level being more than 40 µg per litre. The remaining parts of the country still exhibit goitre in varying degrees of intensity. For instance, low rates are seen in the province of Zeeland; very high rates in the Gelderse Achterhoek.

Results of the Netherlands survey support the view that iodine deficiency is the primary cause of endemic goitre in the country. Food is the most important natural source of iodine; drinking water ranks second, and, if the iodine content is high, may be the decisive prophylactic source of the
element. Proximity to the sea is of no practical consequence. In test subjects, thyroid uptake of radioactive iodine in an endemic area was avid and rapid.\textsuperscript{310, 311}

Medical examination of children with and without goitre (but comparable in regard to age, sex and social class) revealed a better nutritional state in the goitre-free group; onset of puberty is on the whole a year later in goitrous than in non-goitrous children; systolic blood pressure is significantly lower in goitrous children; and in the intellectual and emotional sphere, goitrous children are at a disadvantage compared with their non-goitrous counterparts.

The Netherlands goitre campaign is a model of what can be done with determination and efficient management to rid a country of this disease. Within 20 years the youngest generation—children below 5 years of age—has been freed from the menace of goitre; serious cases are no longer observed among adults; the prevalence of moderate thyroid enlargement is decreasing steadily; and no harmful consequences of iodine prophylaxis have been reported (De Josselin de Jong\textsuperscript{301}).

This account of goitre in the Netherlands would be incomplete without mention of the recent investigations of Binnerts,\textsuperscript{298, 299} who, building upon the earlier studies of Brouwer and Wiertz, has clearly shown that as one passes from severely goitrous areas through mildly goitrous areas to regions where there is no goitre, there is a corresponding rise in the iodine content of the cow’s milk collected.

**Eastern Europe**

**Poland**

Practically the whole of the south of Poland is goitrous. The disease occurs with high intensity in the Voivodship of Kraków, in Lower Silesia, and all along the northern slopes of the Carpathian Mountains westward into Sudetenland. In these parts the goitre rate is always about 10% and in some localities—notably in the Myślenice and Nowy Sacz districts of Kraków Voivodship—rises to 40% or even 60% (Hauke;\textsuperscript{320} Samelson;\textsuperscript{331} Chodźko & Tubiasz;\textsuperscript{313} Tubiasz;\textsuperscript{332–334} Nowakowski\textsuperscript{330}). In 1953 Czyżewski et al.\textsuperscript{318} examined 6000 people in Lower Silesia and found pronounced thyroid enlargement in 17.8% of 3195 women and in 9.8% of 2805 men. Król & Stylo\textsuperscript{324} found 38% of cases among the 48 774 persons they examined in the Voivodship of Kraków in 1957.

Goitre is also endemic in central and eastern Poland, in such places as Poznań, Zielona Góra, Krotońszyn, Leszno, Kalisz, Łódź, Warsaw, Kielce and Lublin. Here, the prevalence, although significant, is somewhat lower than in the south, being 13% in districts around Poznań and 21% to 28% at Krotońszyn (Czyżewski & Falkiewicz\textsuperscript{315}). The disease is not endemic in the Voivodship of Białystok in the north-east of Poland where Karbowsk\textsuperscript{323}
examined 3421 men, women and children during 1953-1957. Nevertheless, Karbowsk
advises the application of iodine prophylaxis as a safety measure.

Surveys are now in progress at Gdańsk, Sopot and Gdynia on the Gulf of
Danzig, and at Koszalin somewhat farther to the west, to ascertain
whether goitre is of current public health significance in the northern section of
Poland. Interest will centre on whether the findings confirm those of Liek 325-329
published between 1925 and 1929 that goitre does in fact occur in this area, albeit without great severity. Incidentally, Liek is one of those
who reject the "iodine-lack" theory of causation.

Before the 1939-45 war a National Goitre Committee was established to
collect statistical data and to apply prevention by iodized salt—a measure
introduced in the Voivodship of Kraków on 1 January 1935. The results of
this committee’s work, available in papers by Tubasz 334 and Heller, 321
show that an average rate of 17.6% of goitre among military recruits in
Kraków Voivodship over the five years prior to salt iodization was reduced
to 2% by 1938, that is, after three years of iodized-salt prophylaxis. This
rapid and marked decrease in the goitre rate occurred with a salt iodized
at a level of 1 in 200,000 and only in districts where the salt was employed.
It was not observed elsewhere.

Post-war investigations have established that the distribution of goitre
in Poland corresponds in general with that prevailing before the war, but
the intensity of the disease has increased. The endemic is severest in the
south, and individuals who have left goitre-free districts to come to live in
Lower Silesia are known to develop goitre there. It appears, too, that a
hitherto unknown endemic focus of considerable intensity exists in the
region of Poznań. According to Heller, 322 the rise in goitre incidence in
Central Europe (a similar increase has been found in Germany) was to be
expected owing to quantitative and qualitative defects of diet during the war.
He also attributes the rise to changes in fertilizer practice. In former times
Chilean nitrate of soda, which contains a significant proportion of iodine,
was extensively used in Poland; it has now been superseded by synthetic
nitrogen fertilizers containing no iodine. Another contributory factor is
said to be the cessation of kelp-burning for iodine on the coast of Brittany.
Considerable volumes of iodine vapour from this source were carried inland
by the prevailing winds, and Heller estimates that at one time about 14 tons
of atmospheric iodine annually fell in rain on to Central European soils.
The validity of this supposition is fully discussed in the Geochemistry of
Iodine. 312

The increased post-war severity of the disease has prompted the Ministry
of Health to institute a preventive campaign on a national scale, and
provincial goitre committees have been set up in Kraków, Lublin, Poznań,
Warsaw, Katowice, Rzeszów and Kielce, with the duty of mapping the
extent of goitre in Poland and organizing the distribution of iodized salt.
The red hatching indicates the areas where endemic goitre has been found.
Iodized salt was re-instituted in the Voivodship of Kraków in 1946 and was introduced for the first time in that of Wrocław in 1949.

To make it possible for just comparisons to be made of results from different districts, the Ministry of Health have recommended the adoption throughout Poland of a uniform scale for measuring the degrees of goitre. A modification of the classification of Nowakowski is favoured—namely, group 1, in which the enlargement is less than half the size of the fist of the person examined; group 2, visible thyroid enlargement equal to half the size of the individual's fist; group 3, enlargement equal to the size of the individual's fist; group 4, enlargement greater than the size of the individual's fist.

A unique feature of the Polish preventive campaign is the proposal to transfer for a time all pregnant women and small children from endemic valleys to higher localities where goitre is non-existent. This "settlement operation", as it is called, is based on experience in Switzerland, where as long ago as 1849 it was found that children transferred in this manner did not develop goitre to such an extent as those who had not changed their habitation.

An evaluation of the iodine prophylactic programme in Lower Silesia has recently been made by Czyżewski et al.\textsuperscript{319}

**USSR (excluding Estonian SSR, Latvian SSR and Lithuanian SSR)**

In point of goitre distribution, the vast territories comprising the Union of Soviet Socialist Republics may conveniently be divided into three sections—European, Caucasian, and Asiatic.

*European section*

In the European section eastwards as far as the Ural Mountains, which form the natural physical boundary of Europe, goitre occurs endemically in several places. To the north-west numerous cases are found on the eastern shores of Lake Ladoga and in the area between Lake Ladoga and Lake Onega, particularly in the valley of the river Oyat and throughout the district of Olonetz. This focus may be regarded as an extension of the Finnish endemic.

Byelorussia (White Russia) exhibits goitre in and around Minsk, and, farther south, in the marshy low-lying country drained by the Pripyet and the Beresina rivers where about 20\% of the schoolchildren are sufferers, but there is no cretinism. The Ukraine has several goitrous localities, notably at Chernigov in the north-west and at Sumi, Kharkov and along the Tim river nearer the centre. South-eastwards from Kharkov there is goitre in the industrial district of Lisichansk-Rubezhansk.

The higher mountainous country towards western and south-western Ukraine bordering on Poland, Czechoslovakia and Romania is severely
goitrous in many parts. An extension of the Polish endemic is found at Lvov and in the Region of Volhynia, where the disease is reported to be mainly of the hyperthyroid and large colloid type, accompanied by considerable dental caries and severe disturbances of the circulatory and digestive systems.

Farther south, the Carpathian mountains carry the malady from Czechoslovakia and Romania into the West-Ukrainian areas of Stanislav Bukovina, Chernovitskaya, and northern Moldavia. Immediately to the south of Chernovitskaya there is a zone of high prevalence (56.5%) in the Vaškovskij district along the foothills of the Prut-Siret watershed. Here, the drinking waters contain an average of 0.55 μg of iodine per litre, whereas throughout the Kelmeneckij district in the neighbouring Prut-Dniester watershed to the east, the local drinking waters contain 2.15 μg of iodine per litre (Shvetz 416) and, correspondingly, no goitre is seen.

Another goitrous region in the European section of the USSR lies to the north-centre, relatively close to Moscow. The areas affected are to the north-east of Moscow at Yaroslavl, Kostroma and Ivanovo, and to the south at Serpukhov, Ryazan, and along the river Oka which drains part of the Central Russian Uplands.

Proceeding eastwards towards the Ural Mountains one crosses a belt stretching from Kirov in the north to Saratov in the south. In the northern part of this belt, goitre is found on the Vyatka river near Kirov and in Mari Region between Gorki, Chuvash and Kazan. The adjacent province of Tatar is also goitrous. Farther down the Volga basin goitre occurs in the regions of Alatyr, Ulyanovsk, Penza, Kuznetsk, Syzra and the lower Volga town of Saratov. The valley of the river Sok and the neighbouring area of Kuibyshev (Samara) east of Syzra are also reported to be goitrous.

In the main chain of the Urals goitre is found at various places, but particularly in the centre, on both the western and eastern slopes. The valley of the river Sylva and the nearby towns of Perm (Molotov), Debessy, Kungur, Krasnofimsk and Birsk are the chief seats of the disease on the western slopes. On the Siberian side, Sverdlovsk and Chelyabinsk are the principal goitre regions of the central Urals.

Caucasian section

In the Caucasus, centres of goitre and cretinism are found all along the southern declivities of the mountains. In the north-west, the valley of the Kuban river, which flows westward through the Territory of Krasnodar to enter the Black Sea just south of the Sea of Azov, is stated to have a goitre rate of 40% among the female population. High rates are also found in the adjoining areas of Karachaevsk and Kabardino-Balkarsk, especially around the Elbrus group of mountains.

In Gruzia (Georgia) the valleys of the rivers Ingur, Adzhars-Tskhali and Rion, which flow near Kutaisi into the eastern end of the Black Sea north of Batum, are well-known goitre areas, and in the neighbourhood of
Batum itself there is an intense focus in the mountainous districts of Adzharistan.

In 1938, Gelovani reported what was then a new endemic locality in Letshkhoom, an upland area of Georgia bordering on the lower part of Svanetia. Here, 52% of the people suffer from goitre and there is much cretinism. The water-supply of Letshkhoom villages is derived from shallow wells, to which the larger domestic animals also have access, and which have been proved by chemical analysis to contain little or no iodine.

In central Caucasia there is a goitre focus in the valley of the river Aragwa in Georgia north of Tiflis. At the east end of the range in the vicinity of the Caspian Sea there are centres of goitre at Gunibsk and Laksk in Daghestan, and near Shemakha in the Republic of Azerbaijan west of Baku. Goitre occurs also in the extreme south of the Caucasian region, particularly at Ordubad where the provinces of Nakhichevan, Armenia and Azerbaijan adjoin. The overall goitre rate at Ordubad in 1959 was 28.8% (Alikishibeko).

**Asiatic section**

Eastward beyond the Caspian Sea, over the great Kara Kum desert and through Turkmen, there lie the Republics of Uzbek, Tadzhik and Kirghiz, which together encompass one of the most notorious goitre areas of the world. In Tadzhikistan an inverse relationship has been found between the prevalence of goitre in certain districts and the amount of iodine present in local foods and water. Experiments to control goitre by the iodization of bread have been undertaken in these localities.

The central Asiatic endemic begins at Bukhara and Samarkand and reaches its greatest intensity in the Region of Ferghana (Kirghiz), especially in the Chatkal Mountains, around the towns of Tashkent, Kokand, and Andizhan. To the south of this area, abutting on the extreme north of Pakistan, lies the Pamir plateau, where in some valleys—notably that of the river Wanj which flows into the head-waters of the great river Oxus (Amu-Darya)—the entire population without exception is said to suffer from goitre. The goitre endemic of Ferghana and the Pamir plateau is continuous with that extending south-eastwards through Kashmir and the Himalayas.

Grouped with the Ferghana focus is the endemic found throughout the mountains of Semirechensk in "The Land of the Seven Rivers" between Lake Issyk-Kul in the north of Kirghiz and Lake Balkhash in Kazakh (formerly Turkestan). It was in this part of the world that Marco Polo saw goitres when on his famous travels from Venice to the court of the Grand Khan in China about the year 1275. After passing through the high Pamirs he came to the Chinese provinces of Kashgar and Yarkand at the

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*a Kokand has been described as "a city of cretins" (Brit. med. J. 1905, 1, 34).*
extreme western end of the Takla Makan desert in Sinkiang (Chinese Turkestan). Writing of the people in Yarkand, Marco Polo \(^{388}\) says: “They are in general afflicted with swellings in the legs, and tumours in the throat, occasioned by the quality of the water they drink.” The leg swellings were due to elephantiasis.

Elsewhere in the Asiatic section there are three major goitre areas. These lie in the south of central Siberia, one at the head-waters of each of the three great parallel northward-flowing Siberian rivers—the Ob (or Obi), the Yenisei, and the Lena.

Proceeding from west to east, the first of these three districts extends from the Altai Mountains, at the north-west corner of the Mongolian plateau, northwards to the town of Tomsk. The endemic is especially severe in the middle and west Altai, that is, in Ojratsk, and covers the area of the sources of the rivers Ob, Bija, and Katun in the east Altai district of Kusnetz.

The second focus lies in the upper basin of the Yenisei and centres round Tulunsk, a town on the trans-Siberian railroad midway between Krasnoyarsk and Irkutsk. The river Uda flows northwards through goitrous regions at this point. Somewhat to the south-west of Krasnoyarsk the disease is rife in the Khakassia region where it has been a special problem among children and adults on the site of the Abakansk railroad construction. Still farther east one encounters a considerable endemic around Lake Baikal and the head-waters of the river Lena. Here, in the neighbourhood of Irkutsk, about half the population are goitre sufferers. In the middle reaches of the Lena a goitre belt stretches for more than 600 miles from Kirensk to Yakutsk.

East of Lake Baikal, in Buryat-Mongol and Chita (formerly Trans-Baikalia), goitre is found in two more or less circumscribed areas—one in the district watered by the river Chilok, which flows into the south-east end of Lake Baikal, and the other on the eastern slopes of the Yablonoi Mountains, particularly at the town of Nertchinsk and at the confluence of the Shilka and Argun with the Amur, rivers which form the boundary between this part of Soviet territory and the north of Manchuria. Here, the goitre rate may reach 74%. Arndt \(^{340}\) records that goitre is often found in association with local endemics of osteo-arthritis. Domestic animals are also affected with goitre in this area.

Finally, at the extreme east of the USSR goitre is found in the Primorsk Region, that strip of mountainous eastern seaboard territory extending from the mouth of the river Amur in the north to Vladivostok in the south.

*Goitre prevention throughout USSR*

Throughout the whole of the Soviet Union an enormous amount of systematic and painstaking analytical and survey work has been carried out to establish the causes of goitre in different parts of the country and to
elucidate whether incidence is related to excesses or deficiencies of mineral elements in the local soils, waters and foods. These clinical and geochemical surveys amply support the iodine-deficiency theory of causation, a conclusion with which all investigators, although maybe working in areas widely separated, are unanimously and uncompromisingly in agreement. As a consequence, organized preventive measures have been instituted under government auspices in almost every part of European and Asiatic Russia where goitre occurs.

One or two salient features of this All-Union effort deserve mention here:

Several investigators have been preoccupied with the environmental relationship between high manganese and low iodine. At the Kazan Medical Institute it has been found that in ordinary foods a high manganese and a low ascorbic acid content goes hand in hand with a high incidence of endemic goitre. Similar research in the adjacent Tatar Region has established that a high soil content of manganese occasions a reduced content of iodine in the soil, thereby leading to goitre occurrence (Kamchatnov \textsuperscript{366}, \textsuperscript{367}). Gurevich \textsuperscript{358-360} reached the same conclusion from his studies in far-eastern Primorsk.

As regards absolute iodine content of soils, waters and foods, Shulpinov \textsuperscript{415} found in Mari Region that dry soil in areas of high endemicity contained 122.2 $\mu$g, in areas of moderate endemicity 267.8 $\mu$g, and in areas free from goitre 1597 $\mu$g of iodine per 100 g. The iodine content of the potato in highly endemic areas was only one-thirtieth of that of potatoes grown in non-goitrous areas. Savchenko,\textsuperscript{405, 409} who has made an "iodine map" of the Ukraine, found that the prevalence of endemic goitre was greatest when the iodine content of water did not exceed 1-2 $\mu$g per litre, moderate when water contained up to 2-3 $\mu$g per litre, and low when the level reached 3-4 $\mu$g per litre.

Results of iodine prophylactic measures are recorded by many observers. Bergman \textsuperscript{345} testifies to their effectiveness in Transcarpathia. A re-survey of the Sverdlovsk region in the years 1957/59 revealed goitre rates one-fifth to one-third of those prevailing in 1929/31 when iodine prophylaxis was first introduced. After five years of systematic treatment with iodized salt (1952-1956/57) in the Stanislav area, goitre rates fell from 10.9\% to 6.9\% in the whole population, from 29\% to 15\% in expectant and nursing mothers, and from 17\% to 11\% among schoolchildren. The beneficial results of long-term iodine prophylactic programmes, extending over 25-30 years, have been documented by Nikolaev\textsuperscript{400} for Russia as a whole, and by Mamedov and Orudzhiev \textsuperscript{587} for the Caucasian republic of Azerbaidzhan.

In the all-embracing biogeochemical studies carried out in the USSR, animal goitre has not been forgotten. Few countries can boast a map more detailed and comprehensive than that prepared by Koval’skij \textsuperscript{377} showing areas in which deficiency or excess of mineral elements in the soil may affect
human and animal health. Soils of the non-chernozem zone of the Soviet Union are poor in copper, cobalt and iodine, a fact that influences the content of these microelements in fodder plants and therefore leads to animal diseases due to their deficiency.

The foregoing review of goitre distribution throughout the USSR is based on information taken from the comprehensive treatise on the subject by Arndt and from papers by the following authors; localities with which particular authors are specially concerned are given within brackets.

**European section:** Aber (Ukraine); Antonov (Stanislav); Bergman (Transcarpathia); Chekalov (Kostroma and Ivanovo); Davidova (Transcarpathia); Fedinets (Transcarpathia); Florinskii (Yaroslavl); Goncharov (Tatar & Mari); Ionisyants (Smolensk); Kamchatnov (Kazan); Kamchatnov (Tatar & Mari); Karpova (Yaroslavl); Kharitonova (Sverdlovsk); Kutsherenko (Ukraine); Kutsherenko, Judina & Kutsherenko (Chernigov); Kutsherenko, Judina & Rimak (Volhynia); Landishev (Tim River); Lyapustin (Urals); Mayer (Arctic); Meshchenko (Transcarpathia); Plotnikova (Sverdlovsk); Primak (Ukraine); Rodnjanski (Byelorussia); Rybalkin (north Bukovina); Savchenko (Ukraine); Schermann (Mari); Shinkerman (Bukovina); Shmagina & Usmanova (Tatar); Shulpinov (Mari); Shvetz (Chernovitskaya); Skatkov (Moscow district); Tabakov (Birsk); Tikhonova & Shifman (Lisichansk-Rubezhansk); Tsarikovskaya et al. (Lisichansk-Rubezhansk); Udod (Stanislav Region).

**Caucasian section:** Alfeev (Karachaevsk); Alikishibekov (Ordubad); Aslanishvili (Svanetia); Balakhovskaya et al. (Dagestan); Egorov & Orudzhiev (Azerbaijanzhan); Ionisyants (Azerbaijanzhan); Kalishevskaya (Onskii, Georgia); Kuznetsov (Karachaevsk); Mamedov (Azerbaijanzhan); Mamedov & Orudzhiev (Azerbaijanzhan); Nikolaev (Kabardino-Balkarsk); Nizhibitski (Karachaevsk); Slavin (Kabardino-Balkarsk); Strunnokov (Karachaevsk); Valedinskaya (Kabardino-Balkarsk); Zhukovski (Karachaevsk).

**Asiatic section:** Abdulakhatov (Uzbek); Belikhova (Abakansk); Bolotova (Abakansk); Chukanin & Levitin (Andizhan); Gurevich (Primorsk); Gurevich & Mukhina (Primorsk); Khazan (Tadzhikistan); Khvorov & Ionisyants (Krasnoyarsk); Kolomiitseva (Tadzhikistan); Kruchinina (Uzbek); Masumov (Ferghana); Mirochnik (Khakassia); Nikolaev (Khakassia); Obliarov (Uzbek); Shkarenko (Uzbek).

**Romania**

The most highly goitrinous regions of Romania lie along the Carpathian Mountains running from north to south of the country, and along the
Transylvanian Alps from west to east. Studies by Câmpeanu \(^431\) and by Danielopolu and co-workers \(^432-437\) contain a wealth of information, with numerous distribution maps and illustrations showing what must be among the saddest and most distressing cases of goitre and cretinism ever photographed.

Two areas in which Danielopolu and his associates made a detailed investigation are Bukovina in the north (now part of the Ukraine) and the District of Sibiu, which lies in the centre of the country on the northern slopes of the Transylvanian Alps. In Bukovina, the Czeremosz valley, which traverses the Romanian-Ukrainian frontier, is highly goitrous, as also is the valley of the Moldavitza in the District of Câmpalung-Moldavia. Here, 46\% of the inhabitants examined by Danielopolu had goitre. At Ispas in the Bukovinian district of Storojinet (now in the Ukraine) 465 cases were seen in seven small hamlets. Although simple goitre was commonest, there were many cases of cretinism, myxoedema, deaf-mutism and imbecility.

Among the communes investigated in the Transylvanian district of Sibiu were Tâlmacu with a goitre rate of 21.5\%, Sibiel with a rate of 50\%, and Cisnădie with a rate of 25.4\%. At Ighisul-Nou, in the valley of the Târnava Mare immediately north of Sibiu, Danielopolu found 31.7\% of goitre. Zlatna in the District of Alba Iulia to the north-west of Sibiu is also very goitrous.

Goitre is prevalent in certain parts of Moldavia, on the east side of Romania. Andronovici \(^429\) examined the schoolchildren of thirteen Moldavian towns and found rates of 20.2\% at Fălticeni, 24.1\% at Jassy, 24.5\% at Roman, 34.1\% at Piatra Neamt and 13.5\% at Bacău.

In Romania, goitre is notoriously a disease of poverty. The inhabitants of all the small goitrous villages surveyed by Danielopolu were very poor and lived under exceedingly primitive housing conditions—very often a whole family in one badly ventilated and ill-lit shack together with their domestic animals. There is least goitre among the men who pass a large part of their time in the mountains as shepherds, woodmen and charcoal burners. Social environment in relation to unfitness in military recruits in Romania during the years 1941-46 has been the subject of study by Banu & Dinu,\(^439\) who mention goitre as one of the causes of rejection for service.

Romania now takes her place as one of the countries which has tackled the goitre problem with vision, determination and system. Prior to the year 1944 the State health authorities had done almost nothing to arrest the disease. Shortly before that time attempts had been made to introduce iodized salt\(^a\) and prophylactic dosage with Lugol’s solution into some communities, but as these lacked official stimulus and supervision little came of them. Not until 1947 did the Ministry of Health entrust to

\(^{a}\) Parhon recommended its use in 1908 (Rum. med. Rev., 1, No. 1, 61).
Dr S. M. Milcu the task of organizing an anti-goitre campaign throughout the country.

Under Milcu's direction, fresh surveys were undertaken by specially trained teams of endocrinologists, a goitre map of the country was built-up piece by piece, and preventive measures were set on foot. To cover all the clinical forms and degrees of the goitre manifestation in Romania, Milcu introduced the term "endemic thyroepathic dystrophy", a three-degree classification into which all cases can be grouped according to severity. By a wider coverage of the country, and by uniform methods of examination, Milcu and his colleagues gave precision to earlier assessments of the extent and seriousness of the endemic. Detailed surveys among schoolchildren belonging to communities in the Jiu Valley to the south west, along the course of the Argeş river from Piteşti through Găeşti to Bucharest, in the Muscel region towards the centre of the country, and in the districts around Ploieşti and Slănic, revealed rates varying from 20% to 90%.

Concurrently with these investigations, preventive action with iodized salt (1 in 50 000 strength) was instituted. An iodide tablet (1 mg KI) has also been used. Seven years of experience with these methods have been uniformly good. The rate among schoolchildren has been cut by anything from one-fifth to one-third. Schools in the Muscel region, for example, showed a rate of 81.8% in 1950 and by 1954 this had been reduced to 46.5% as a result of iodine prophylaxis. No more cases of cretinism or congenital goitre in children below the age of 4-5 years have been reported. Milcu and Negoescu emphasize also that no accidents or ill-effects due to mass prophylaxis with iodized salt have been observed.

Full details of all the many-sided aspects of these recent Romanian studies are available in numerous papers and in several impressive volumes published under Milcu's editorship.

**Bulgaria**

Mass examination of 971 864 schoolchildren in 4 036 communities throughout Bulgaria showed that thirty-two provinces were affected with goitre in 1958, twelve severely. The endemic regions are in the mountainous parts of the country; except for a few isolated foci, coastal areas are goitre-free (Penchev et al.).

The disease is markedly prevalent along the banks and tributaries of the west Bulgarian river Struma, which rises in the Vitosha Planina south-west of Sofia and has a general north to south direction, eventually flowing through Greek Macedonia and entering the Aegean at the Gulf of Strimon on the east of Thessalonika. In Greece the spelling of the name changes to Strouma, and in classical times the river was known as Strymon.

The word "Struma" is often used, especially in German literature, as a synonym for goitre—the adjectives "scrofulous", "strymous" and
"goitrous" being nearly interchangeable. Some say that the river was named after the disease. It seems much more likely that the disease took the name of the river in whose valley it abounds.

Two left-bank tributaries of the Struma, the Rila and the Bistritsa, flow through exceptionally goitrous country where surveys have been made by a team under the leadership of Penchev\textsuperscript{455-458} and by Tsvetkov\textsuperscript{462}. On the upper course of the Rila (which joins the Struma midway between Sofia and the northern border of Greece) 62% of a total of 3810 people examined in seven communities had goitres. Newcomers into the area are not long in contracting the disease, and cretinism and deaf-mutism are of common occurrence. On the lower course, a rate of 50.4% was recorded among more than 5000 people examined in the townships of Stob, Porominovo and Kocerenovo near the confluence of the Rila and Struma. In these lower stretches of the river, cretins and deaf-mutes were not evident.

More than 300 families (60% of all households) were examined for thyroid enlargement by Tsvetkov\textsuperscript{462} in the township of Bistritsa situated on the river of the same name flowing through the extreme south of Sofia province into northern Macedonia. Here, 47.3% of the inhabitants were found to be suffering from goitre.

The city and district of Plovdiv towards the centre of the country is yet another goitre area in Bulgaria. Khaidudov, Cherevivanov & Armenkov\textsuperscript{452} associate the goitre endemic in this region with low nutritional standards and poor living conditions.

The goitre rate among adults and schoolchildren in the town of Teteven, about 50 miles north-east of Sofia, was investigated by Ticholov\textsuperscript{461} in 1926 and again in 1947. In the former year about 10% of the total population were affected; by 1947 this over-all figure had risen to 20%, and the rate among schoolchildren was as high as 80%. In the village of Ribaritsa, a strong focus of endemic goitre situated about 12 km from Teteven, no less than 81% of boys and 89% of girls were found to be goitrous in Ticholov's 1947 investigation. Teteven was originally supplied with water from local springs and wells; in 1939 the source of supply was changed to water carried by aqueduct from the neighbouring river Beli-Vit. It has not been possible to determine the iodine content of both well and river supplies, but Ticholov assumes that alteration in the chemical quality of the drinking-water is the cause of the increased incidence of goitre in Teteven.

On the recommendation of Penchev\textsuperscript{459} Khaidudov\textsuperscript{452} and others, steps are now being taken in Bulgaria to apply iodine preventive measures on a community scale.

**Yugoslavia**

Endemic goitre is a serious public health problem in Yugoslavia, contributing much to chronic ill-health and lowered output; it adds signifi-
cantly to the cost of State medical care. The general distribution of the disease has been described by Simitch,\textsuperscript{493} by Miholić,\textsuperscript{482} by Ramzin, Bučić & Lukić,\textsuperscript{490} and by Matovinović;\textsuperscript{480} detailed surveys of particular areas have been made by numerous other workers whose findings are noted below; the occurrence of thyroid enlargement in domestic animals is discussed by Jovanović, Pantić & Marković;\textsuperscript{475, 476, 483} and the problem of goitre in the army has been the concern of Ceramilac.\textsuperscript{469}

The goitrous area extends continuously for more than 500 miles from Slovenia in the north-west to the extreme south-western corner of the country in the neighbourhood of Bitolj (Monastir) and the lakes Presba and Okrida in Macedonia. The only goitre-free areas lie along the Adriatic coast and throughout Vojvodina in the north-east. The intensity of the endemic varies. It is highest on the banks of the river Ibar and in certain valleys of the Zlatar Planina in the sandjak of Novi Pazar, i.e., in the south-western part of Serbia. Slovenia, too, has high rates; and severity is considerable in Croatia, in Bosnia and Herzegovina, and in northern Montenegro. Goitre in Yugoslavia is mostly located in high mountain districts and tablelands, but is also found in river valleys and in the plains.

\textit{Slovenia}

In the north-west of the country (Slovenia) there is considerable goitre throughout the head-waters of the rivers Sava and Drava (Danube) between the towns of Ljubljana and Maribor (Marburg). This centre, which is an extension of the Klagenfurt-Graz goitre area in southern Austria, has been specially studied by Arko,\textsuperscript{465} who mentions the following places as goitrous: the mountains of Kozjak, Pohorje and Haloze, and the low-lying area of the Pannonian plain in the vicinity of Beltinci. Arko very carefully examined 257 children (up to 14 years of age) in the village of Zetale near Rogašk Statina and found goitre in 60\% of them.

\textit{Croatia}

An investigation of the Croatian villages of Rude and Braslovje, in the near vicinity of Zagreb, undertaken jointly by the Institute of Hygiene and the Clinic of Internal Medicine, Zagreb, showed thyroid enlargement in 83.3\% of 856 persons examined. More than 58\% of these cases had severe goitres of the first degree, and 10\% of the total population of the two villages were handicapped for hard physical work on that account. Twenty cretins were found among the 856 people examined (Ferber et al.;\textsuperscript{470} Matovinović\textsuperscript{480}). Buzina et al.\textsuperscript{467} say that in Croatia goitre is most widespread in the district of Jastrebarsko south-west of Zagreb and in Virovitica situated due east of the capital almost on the Hungarian border.

Prebeg et al.\textsuperscript{486} examined 21 482 Zagreb schoolchildren in 1953/54 prior to the compulsory iodization of salt and found an overall goitre rate of 46.5\%, the proportion being 42.2\% in boys and 50.9\% in girls. They
confirmed the well-known finding of many earlier investigators that goitre develops more readily in rapidly growing children—the tall, heavy, rather dull pupils at school. The physiological demand for thyroid hormone is less in smaller, lighter children, among whom thyroid enlargement is consequently less evident.

Extending their studies from the Croatian mainland to the adjacent Adriatic islands, Ferber & Buzina (quoted by Horvat & Maver 473) noticed a high incidence (40%-46%) of goitre on the island of Krk, whereas on other neighbouring islands the disease is very rare or wholly absent. On closer investigation of this interesting phenomenon, Horvat & Maver 473 reached the conclusion that goitre in Krk is the result of a complex nutritional deficiency involving not only lack of iodine but also deficiency of vitamin A. Subsequent studies with 131I do not, however, entirely support this suggestion; it seems that a low iodine intake, aggravated no doubt by factors impairing iodine utilization, is the dominant goitre-producing agency (Buzina et al.; 468 Horvat et al. 474).

*Bosnia and Herzegovina*

Although endemic goitre in Bosnia and Herzegovina has been a subject of intermittent study for more than 80 years—indeed, since Austrian replaced Turkish rule in 1878—exact information did not become available until the modern surveys of Žarković & Radovanović 494 conducted under official auspices. In 1953 the Yugoslav Commission for Medical Scientific Research sponsored a study in the district of Srebrenica north-east of Sarajevo and found 75% of all schoolchildren had manifest goitre.478, 494 Three years later (1956), an organized mass examination of 34,343 persons of all age-groups over six years drawn from 975 settlements spread throughout the entire Republic of Bosnia and Herzegovina (approximately 1% of the total population) exposed an average goitre rate of 20% among males and 33% among females. The districts of Brčko, Sarajevo, Goražde, Fojnica and Trebinje in the eastern section of the country, and Banja Luka in the north, are hyperendemic regions. Contrary to earlier assumptions, the Sava river valley in the north was found to be as strongly goitrous as the Drina valley in the south.

No positive correlation was established between the amount of iodine in drinking water and the prevalence of goitre in Bosnia and Herzegovina; but this, as Žarković and Radovanović 494 say:

...cannot be taken as proof that lack of iodine is not the most important single agent in the epidemiology of goitre. First of all, the analysis of one sample of water—let alone a sample taken at the time of the lowest water-level in sources and wells—cannot be considered representative of the annual content of iodine and still less of the iodine content in a decade. Besides, water is not the only source of iodine for the population. Big differences in the types of food and in their iodine content are characteristic of Bosnia and Herzegovina, and certain foods might compensate for or aggravate the lack of iodine in the water. Finally, the differences in goitre prevalence among people with equal con-
sumption of iodine might be produced by a series of other influences, including differing doses of various goitrogenic factors.

**Serbia and Montenegro**

Much has been written about the severe south Serbian focus, which includes the valleys of the Lim, Uvac, and other rivers flowing from the Zlatar Planina, the towns of Nova Varos, Prijeopolje, and Novi Pazar, and extends eastwards over the river Ibar to the Kopaonik and Jastrebac Mountains in Moravia, with a southwards branch into the Kosovo-Polje plains and the valley of the river Vardar at Skopljë. Simić et al. 492 found a rate of 6% to 12% in 147 families (758 individuals) in three villages of the Šumadija region. Gvozdenović 472 records a morbidity varying from 37.8% to 60.7% among the people of Mataruge in the Kraljevo district of central Serbia; and in the village of Gornja Jošanica in the Jastrebac mountains, Kičić & Radmili 478 diagnosed nodular goitre in no less than 366 (57.6%) out of 759 persons examined. Olive Lodge 479 in her book *Peasant Life in Yugoslavia* writes that 80% to 85% of the population of the sandjak suffer from enlarged thyroids.

The detailed survey made by Schneider & Ganss 491 in the villages and valleys surrounding the Zlatar Planina offers good examples of the variations in prevalence which may occur within a comparatively small area. At Hisardžik, a small mountain village of 250 people situated on the southern slope of the deep valley of the river Miloševce, 60 out of 80 persons examined had pathologically enlarged thyroids. Further up the same valley, at Karaula, there was no goitre at all; nor could any cases be found at Kačevo, a settlement close to Hisardžik. Similarly, in the not-far-distant Kosatica valley the upper reaches are goitre-free while the lower part is distinctly goitrous. High up on the top of the Zlatar Plateau itself, goitre is completely unknown, but in the northern declivities at Nova Varos and lower down the Bistrica valley “lovely” goitres are seen.

Schneider & Ganss 491 attribute these variations to sharp distinctions in local geology and topography. Goitre occurs only in valleys, not on plateaux. Valleys in which the slopes are chiefly covered with soft rich soils are not goitrous; those with steep wall-like sides scantily covered with poor soil favour the disease. The incidence is higher where faults and folds predominate, and at the intersection of strata of different ages.

In northern Montenegro goitre is prevalent throughout the upper basin of the river Lim, particularly in the neighbourhood of Bijelo Polje, and cretinism is of frequent occurrence (Gušić et al. 471). Macedonia at the extreme south of Yugoslavia is another region of high prevalence, especially in mountain areas where chestnut trees abound (Petrov 485).

Jovanović, Pantić & Marković 475, 476, 483 describe hypothyroidism occurring among domestic animals in areas where the human population suffers from goitre. Goats showed most thyroid enlargement but no signs of
dwarfism, sterility or low vitality. In sheep, the thyroid enlargement was not so pronounced but poor lactation, poor wool production, and a high mortality rate among lambs were noteworthy. Sterility, low milk yield, short lactation, too frequent silent heat, and poor condition of young stock are the symptoms of hypothyroidism reported in cattle. Little abnormality was seen in pigs. Horses also suffer from goitre, the incidence being higher in primitive than in important breeds. Affected animals were less able to work, and stallions had decreased sexual impulse. Foals do not develop normally and are often stunted.

Owing to the seriousness of the goitre endemic in Yugoslavia, the Government is giving every support to control programmes, and, in keeping with recommendations made by the World Health Organization, has passed a law, effective from 1 July 1954, requiring the iodization of salt at a level of 10 mg of potassium iodide per kg of salt. Salt-iodization plant has been installed on a pilot scale and will be increased until all salt distributed for human consumption is iodized in conformity with this regulation (Matovinović; 480 Brožek & Ferber 466).

Albania

In Albania thyroid disease is known at Berat towards the south of the country. There is no published literature on goitre in Albania; the foregoing information was communicated privately by C. Evelpidi (1948).

Greece

Reports communicated privately by Evelpidi (1948) of goitre in and around Poroy, Djuma and Sérrai (three towns situated on the edge of the lowland Grecian slopes where the Struma valley broadens into the plains of Greek Macedonia) and also farther west at Karadjova in the Yiannitza-Vardená area, have been confirmed by Hadjidakis.495 His field enquiry, part of a State programme to improve Mother & Child Welfare, involving the clinical examination of almost 12,000 children and youths, disclosed a goitre rate of 53% in an appreciable number of villages in the northern districts of Greece, especially in Thessalonika, Macedonia, and Epirus. Although iodine deficiency could not be chemically proved, the fact that in some instances goitre prevalence diminished following iodine administration indicated the probable influence of this agency.

Central and Southern Europe

Austria

Goitre has long been a concern of Austrian preventive medicine. Prophylactic admixture of potassium iodide with common rock salt in the proportion of 1 part of iodide in 10,000 parts of salt was strongly recom-
mended by Köstl in 1855, more than 100 years ago. With the exception of a few districts in the Danube valley and in the direction of the Hungarian plain to the east, practically the whole country is goitreous. From west to east the most notorious localities are:

1. The Province of Vorarlberg, which is bounded by the Swiss Alps, Lake Constance and the Algauer Alps to the south of Bavaria. Here, the district of Montafon south of Bludenz is specially affected.

2. The Tirol, especially in the neighbourhood of Telfs and Innsbruck.

3. The Province of Salzburg, particularly along the river Salzach at Zell-am-See and Taxenbach. The city of Salzburg itself has a high goitre rate.

4. The Province of Kärnten (Carinthia), especially the area around Klagenfurt. This includes the valley of the river Drau (Drava) and the towns of Friesach, Wolfsberg and St. Paul.

5. The Province of Steiermark (Styria) where the areas around Murau and Judenburg have a high incidence. The town of Graz on the eastern edge of the Styrian Mountains and many other places along the valley of the river Mur are mildly goitreous.

6. Upper Austria in the vicinity of Vöcklabruck, Bad Hall, Steyr, and Rohrbach north-west of Linz.

7. The extreme east of the country is the least affected. Nevertheless, many cases are found in Burgenland Province on the borders of Hungary, and in Vienna, the capital city (Schroetter; Burtscher & Sprenger; Wagner-Jauregg; Bauhofer; Kopf; Kutschera-Aichberger).

The prevalence throughout Austria is high. Taking the country as a whole, 44.2% of boys and 48.1% of girls were found to be goitreous in the 1923-24 survey of 686,000 schoolchildren organized by Wagner-Jauregg. The highest regional rates were in Vorarlberg Province, with percentages of 58.9 in boys and 63.6 in girls. The lowest rates were in Burgenland Province, with 15.9% in boys and 19.5% in girls. The city of Vienna showed percentages of 41.1 in boys and 46.2 in girls.

The situation in more recent times is scarcely less acute. A survey of five groups of Viennese civilians under United States occupation in 1945 revealed non-toxic diffuse goitre in from 21% to 42% of those examined, the rate in children under 14 years being 38% in boys and 35% in girls (Davidson et al.). In the Upper Austrian town of Rohrbach, notorious for its high goitre rate, the percentage with thyroid enlargement was 31 in 1952 compared with 66 in 1946. The drop is due to the adoption of iodine preventive treatment. At Bad Hall, an Upper Austrian watering-place well known for the high iodine content of its drinking-water, about 11% of schoolchildren are affected. In contrast, the rate among children living outside the town in nearby districts is 35% or even higher. In Steyr,
for instance, the rate for children is 49%. The fact that 11% of Bad Hall children have goitre in spite of a high iodine intake from water is evidence that iodine deficiency is not the whole etiological explanation; goitrogens in food, bad hygiene, or other factors may also be involved (Kopf). Studies of the occurrence of endemic goitre among people who have moved from goitre-free areas into affected areas have been made by Schreckels. He examined 2220 such people in and around Salzburg and found that within a year of coming to live in the goitre area 40% of them developed thyroid enlargement. The longer the people had been settled in the area, the higher was the prevalence of goitre among them.

A feature of the goitre endemic in Austria stressed by Kriebernig is the increase in prevalence which has taken place in post-war years, especially in the newborn. This happened both after the First World War (Abels) and after the Second. Sollgruber gives the following figures: among 4800 newborn infants examined in the ten years 1944-53 in the maternity ward of Dornbirn hospital in Vorarlberg, the average goitre rate was 7%; in the two years 1952 and 1953 the rate was 11% and in the first quarter of 1954, 20%. Sollgruber treats these infants from the third day of life with large doses of iodine spread over several days. He strongly recommends the general use of iodized salt and considers it should be the standard salt on sale everywhere, untreated salt being obtainable only on special prescription. Kopf records that, in Vöcklabruck, administration of potassium iodide to pregnant women, preferably from the fourth month, reduced the goitre rate in the newborn from 47% to about 5% in the space of two years.

Hungary

According to Kiss, there are 500,000 goitrous people in Hungary. Endemic cretinism is said to have been known in the country since the 14th and 15th centuries. Broadly speaking, goitre is confined to three main parts of Hungary—the northern frontier, the west-centre and south-west, and the neighbourhood of Debrecen in the north-east. The Great Hungarian Plain in the centre and east of the country is goitre-free.

Upper Hungarian localities affected are: Magyaróvár, on the river Leitha in the extreme north-west, where a percentage prevalence in schoolchildren of 33.3 has been recorded; Komárom, with a rate of 35%; and Tatabánya, with a rate of 59.3% among children. Farther east, children in the northern towns of Vac, Salgótarján and Miskolc in Upper Hungary showed rates of 9.3%, 17.5% and 14.5%, respectively. In the department of Nógrád due north of Budapest on the Slovakian border, Kiss examined 13,683 children and found rates of 10% to 30% in the townships of Nógrád, Salgótarján, Balassagyarmat, Szécsény, Szob and Sziráki. In some communities, notably Buják, Dej tér, Diósjenő, Óhalom, Patak and Romhány, the prevalence reached 50% or more. By contrast, the neighbouring Sóshar-
tyán community could offer only two cases among 1800 inhabitants. Here, the local water, known as “Iodaqua”, is regarded as “medicinal” and contains among other therapeutic ingredients a high proportion of iodine. Besides being goitre-preventive, “Iodaqua” is reputed to have significantly beneficial effects on general health, especially in reducing abnormally high blood pressure. In Budapest and surrounding districts, from 5% to 12% of children are said to be goitrous (Gortvay; Bodnár & Straub; Straub; Sós, Fekete & Molnár).

In the west-central part of the country near Lake Balaton, children in the towns of Sümeg and Tapolca showed rates of 11% and 10.1%, respectively; but at Tihany, which lies immediately on the lake shore, there is no goitre (Straub). According to Véli, schoolchildren are considerably affected in the town of Kaposvár, which lies between Lake Balaton and Pécs. In this general area, too, a goitre endemic among the children of Komló has been reported by Várbiro, Száva & Koch. In Pécs itself, thyroid enlargement is commonly seen in newborn infants, among schoolchildren (who exhibit a rate of 10% to 13%) and in older people (Hal & Horváth; Horváth and co-workers). The iodine content of food and water in relation to goitre in Pécs was determined in 1933 by Scheffer and again in 1949 by Horváth, Nógrádi & Dános. The latter study showed that one part of the city supply contained 4.5 μg of iodine per litre and another part 1.5-2.0 μg per litre. Goitre was commoner in that part of the city supplied exclusively with water of the lower iodine content.

In the extreme east of Hungary, little goitre is seen; but there are exceptions—notably in the neighbourhood of Debrecen, where the following goitre rates have been recorded by Straub & Török: Hajduhadház (11.7%), Vámospércs (22.6%), Újhuta (40%-50%), Óhuta (50%-60%), Budahegyközség (82.2%) and Ómassa (83.3%). In 1947, Kiss drew attention to the increasing prevalence of goitre in Nádudvár, in the Debrecen area.

A feature of the goitre literature of Hungary is the several attempts that have been made to find out whether the radioactivity of soils and their fluorine content are factors implicated in the causation of goitre. Straub & Kovács conclude from their investigations that goitre will not develop from the consumption of fluorine-containing waters if the individual has access to a sufficiency of iodine. If, however, the iodine supply is deficient or the utilization of iodine in the thyroid is disturbed through excess of dietary calcium or for some other reason, then the goitrogenic action of fluorine can manifest itself.

From the results of iodine determinations on more than 700 samples of water collected from goitrous and goitre-free areas, Szabó, Remenár & Demeczky established without doubt that endemic goitre in Hungary is mainly due to iodine deficiency; the degree of hardness of water may also play a part. Independently of hardness or other factors, complete freedom
from goitre is found where the water contains more than 25 \( \mu g \) of iodine per litre. If the iodine value is between 13.5 \( \mu g \) and 25 \( \mu g \) per litre, protection against the disease depends on the hardness, while for values between 5 \( \mu g \) and 13.5 \( \mu g \) per litre freedom from goitre is ascribed, irrespective of the hardness of the water, to a high content of iodine in the soil. Where the water contains less than 3 \( \mu g \) of iodine per litre, goitre appears whether the water is hard or not.

Iodized salt (10 mg of KI per 1000 g of salt) was officially introduced into certain parts of Hungary in 1948, and the results of five years' prophylaxis by this means have been summarized by Sós & Szabó.\(^{526}\) The most marked improvement has occurred in the west and north of the country, particularly among children. No very significant reduction in prevalence has been noticed in the south trans-Danubian region.

**Czechooslovakia**

Maps prepared by Feix, Rezler & Šilink,\(^{539, 540}\) on the basis of the examination of 44 262 men and women and 85 060 children from all districts of Bohemia and Moravia in 1947-48, show that thyroid enlargement of every type is prevalent to a considerable degree throughout the whole of these regions of Czechoslovakia. In some communities the frequency may be as high as 100\% among women.

Data on the distribution of goitre in army recruits collected by Klíma\(^{544}\) in 1933 reveal a marked focus along the Erzgebirge on the Saxony border to the west of Bohemia, especially in the neighbourhood of Karlovy Vary (Karlsbad) and Pilsen. This western belt extends round the northern Sudetenland frontier, through such places as Usti and Liberec, and links up with the Silesian goitre districts of south-west Poland.

Determinations of the urinary output of iodine by individuals in 29 west Bohemian communities situated in the neighbourhood of Liberec, Usti, Prague, Pilsen and Karlsbad have been made by Vohnout & Pihar.\(^{570}\) On the assumption that the minimum iodine requirement is 100 \( \mu g \) per head daily, the results show that people in these regions have an intake of iodine deficient by 30-80 \( \mu g \) per day.

During the years 1949 to 1954, Hostomská et al.\(^{543}\) treated 1931 Prague children in age-groups from 3 to 15 years with thyroglobulin plus iodized salt in strengths of 1 in 100 000 to 1 in 40 000. A considerable decrease in the size of both medium and small goitres resulted. In the Prague area, goitre is also reported from the towns of Dobříš, Roudnice and Sušice (Fleischhans;\(^{541}\) Šilink & Maršíková\(^{560}\)). In Sušice and neighbourhood, all schoolchildren and most workers in the Union of Agricultural Cooperatives were examined by Horáčková & Pokorný,\(^{542}\) who found hyperthyroidism to be the most common type of thyroid disturbance even where cretinism is traditional. The intensity of the endemic in this district has
decreased since the removal of people from the most seriously affected areas; nevertheless, prevalence remains high and presents a grave health problem, especially among children in upland areas. The systematic use of iodized salt is strongly urged by the authorities.

With the object of measuring the prophylactic effect of iodized salt administered over a period of years, Šílink, Reisenauer & Chaloupský recently (1959) evolved a procedure to solve the problem of uniform and objective mapping of goitre. The value of their method has been demonstrated in Bohemia and Moravia where, as a result of iodization, the average mass of the thyroid gland in adult women has been reduced by 12% in seven years, namely, from 41 g in 1948 to 36 g in 1955. Important recommendations on the standardization of iodized salt and on the means of removing influences affecting its prophylactic efficiency have been made by Reisenauer & Likar and by Šílink & Reisenauer.

Moravia, the central part of Czechoslovakia, is heavily goitrous, particularly in the north. Local goitrogenic factors have been investigated by Šílink & Maršíková, who determined thiocyanate values in the blood of volunteers from Šumperk in northern Moravia and Roudnice in Bohemia, two districts where goitre is rife. These values are higher in autumn, when the consumption of fruit and vegetables is greatest, than in the spring, and there is a direct relationship between the amount of thiocyanate in the blood and the degree of thyroid hyperplasia.

This does not mean, however, that thiocyanate itself is the goitrogenic factor, because the serum thiocyanate values in the goitre subjects from Šumperk and Roudnice are no higher than those found in subjects who had been given less than 0.1 g of potassium thiocyanate by mouth for long periods without the thiocyanate having any goitre-producing effect whatever. Šílink & Maršíková argue, therefore, that the foods consumed by the inhabitants of these districts contain not only a substance capable of raising the blood thiocyanate level, but also a specific goitrogen which they have not been able to identify.

Podoba et al. found a significant difference in the weight and histological picture of thyroids from rabbits fed raw cabbage alone, and from those fed mixed vegetables of the Brassica genus, both raw and cooked. The goitrogenic effect of the cooked mixed vegetables was lower than that of the raw mixed vegetables and significantly lower than that of raw cabbage.

Vomela has studied the Holešov and Fryštát areas of eastern Moravia in great detail. In the mountains, extreme forms of goitre and cretinism are common; 80% to 90% of the inhabitants are affected in some villages. Here, the general picture is definitely one of hypothyroidism. On the Moravian plains, on the other hand, goitre also occurs but is accompanied by tachycardia, exophthalmos and other symptoms of hyperthyroidism. Zones of intermediate altitude show goitres of both types, even within one family.
During his surveys in the district surrounding Ostrava in the extreme north of Moravia, Doleček found a relatively large number of goitres associated with hypertension and other related disturbances. Doleček is among those who stress the importance of goitrogenic factors in the local foods and the need to employ rational prophylaxis.

Farther east, in Slovakia proper, goitre has been the subject of special study in Banská Bystrica and in the Zitný Ostrov area immediately south-east of Bratislava where Slovakia abuts on Austria and Hungary between Vienna and Budapest. This focus is noteworthy inasmuch as the disease is more prevalent in the lowlands than in the surrounding mountains (Tománek; Podoba, Németh & Grmelová; Németh & Podoba).

Following an extensive survey of the Zitný Ostrov area by the Bratislava Institute of Endocrinology in 1949, iodized salt was introduced in October 1950, first at a level of 1 in 200 000 and later at a level of 1 in 100 000. A resurvey carried out in 1954 on 17 750 persons of both sexes, ranging in age from 6 to 20 years, showed that there had been a distinct recession of the endemic, a decrease in the number of nodular cases, and a striking diminution in the size of local goitres (Németh & Podoba).

Finally, in the extreme east of Czechoslovakia there lies Carpathian Ruthenia—now part of the Ukraine—where, in the vivid description of Suk, goitre and its consequences (cretinism and myxoedema) may be seen at their worst. Here, the most wretched centres are the poor villages, in which, during the unfavourable winter months, the people live an unhealthy life in dark and cold unventilated huts. They consume large quantities of cabbage—raw cabbage, pickled cabbage, boiled cabbage and cabbage water. Indeed, cabbage is the staple diet. The goitrogenic effect of cabbage is revealed in the data collected by Suk in a number of out-of-the-way villages in the Carpathian highlands (see Table VI).

It is seen that the percentage of cases without goitre is much higher in all villages taken together than it is in the three villages where the consumption of cabbage is excessive.

<table>
<thead>
<tr>
<th>Results of examination</th>
<th>All villages taken together</th>
<th>Three villages with excessive cabbage diet</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>number</td>
<td>percentage</td>
</tr>
<tr>
<td>Without goitre</td>
<td>136</td>
<td>25.2</td>
</tr>
<tr>
<td>Slight goitre</td>
<td>262</td>
<td>48.6</td>
</tr>
<tr>
<td>Medium goitre</td>
<td>100</td>
<td>18.5</td>
</tr>
<tr>
<td>Large goitre</td>
<td>41</td>
<td>7.6</td>
</tr>
<tr>
<td>Total examined</td>
<td>539</td>
<td></td>
</tr>
</tbody>
</table>
The foregoing is but an outline of the goitre problem in Bohemia, Moravia and Slovakia. Medical literature of Czechoslovakia in recent years is rich in research on regional and etiological problems, of which only bare mention is possible here: Németh,550 and Németh & Štukovský552 on the retardation of bone development among children in goitre districts; Šilink et al.563 and Reisenauer, Šilink & Röhling550 on the iodine metabolism of people in goitrous areas of Bohemia and Moravia; Langer and his colleagues547-549 on the role of calcium and other dietary factors in the genesis of goitre in Czechoslovakia; Verner569 on the inferior intelligence and mental capacity of children in goitrous regions; and Štukovský et al.565, 566 on the parallelism between human and animal goitre in western Slovakia.

Germany

Proceeding from the south to the north of Germany, it is possible to distinguish five main goitre zones: one extending from Baden-Baden and the mountains of Breisgau and the Black Forest eastwards through Württemberg and southern Bavaria to the Austrian border; one in the Vogtland and Erzgebirge on the north-western frontier of Czechoslovakia; one stretching from the borders of Luxembourg north-eastwards along the Hunsrück and Taunus ridges through Hesse and Lower Franconia into Thuringia; one comprising Münsterland, parts of Westphalia, and the Bergische Land near Düsseldorf; and one in Brandenburg, extending from the region of Cottbus south-eastwards into Polish Silesia.

The first of these zones includes the Kaisersstuhl area, the valley of the river Kinzig and the towns of Wolfach and Freudenstein in the Black Forest, the towns of Hechingen and Geislingen in Württemberg, and a large number of places along the Austrian frontier between Lake Constance and Salzburg. Among these southern Bavarian centres are Lindau, the Algaier Alps, Kempten, Landsberg, Schongau, Weilheim, Garmisch, Wolfratshausen, Tölz, Ebersberg, Miesbach, Traunstein, Pfarrkirchen and Berchtesgaden. Goitre is also said to occur in the Bayrischer Wald along the north bank of the Danube between Regensburg and Passau.

The second important zone lies between Plauen and Dresden. It covers the Vogtland and the north side of the Erzgebirge and takes in Auerbach, Freiberg, Chemnitz, Oelsnitz, Schneeberg, Marienberg, Zwönitz and Annaberg.

In the third distinctive area, incidence is not excessively high but there are, nevertheless, some well-marked goitre centres. Between Luxembourg and Koblenz the disease occurs in the Eifel district north of the Moselle river—notably, at Prüm, Bitburg and Wittlich. On the south of the Moselle, the town of Bernkastel and the neighbouring ridge of the Hunsrück are affected. Across the Rhine to the east of Koblenz there is goitre within a
circle drawn through Siegen, Giessen, Wiesbaden and St. Goarshausen. This includes the Westerwald and the Taunus country immediately north of Wiesbaden where Königstein is a known focus. A traveller proceeding north-eastward from Siegen to Kassel would find goitre cases at Wittgenstein, Biedenkopf, Frankenberg, Fritzlar, Rotenburg and Melsungen. In the Mannheim-Frankfurt area there is goitre on the Odenwald and in the Spessart country, the town of Heppenheim to the north of Mannheim deserving special mention. Farther east, one finds the disease on the upper Tauber river, at Rothenburg in Middle Franconia, along the Steiger Wald, where Iphofen is a well-known centre, and at Gersfeld in the Rhöngebirge west of Meiningen. In Thuringia, the towns of Weisensee and Schmalkalden are said to be affected.

Fourthly, there is an area of slight endemicity in the Duisburg—Dortmund—Düsseldorf triangle and in the Bergisches Land, a region which rises in plateau-like terraces from the Rhine near Düsseldorf. The nature of thyroid disorder here has been described by Leicher. During their post-war investigation of the nutritional status of children in the British Zone of Germany, Widdowson & McCance found cases of thyroid enlargement in the municipal orphanages at Duisburg and Wuppertal-Vohwinkel.

The fifth zone is found in the far east of Germany. It begins at Guben and Cottbus and extends south-eastwards to join the goitre belts of south-west Poland and northern Czechoslovakia. Goitrous localities of special note in this region are Spremberg and Hoyerswerda.

Throughout the past hundred years the geographical distribution of goitre in Germany has remained fairly constant, but the intensity of the disease has been subject to marked fluctuation. After the First World War, German physicians reported an increase in prevalence all over the country, even in areas normally goitre-free, like Nuremberg, the Ruhr district and the North German Plain. By the end of the 1920’s this outbreak had subsided. The same happened after the Second World War. An upward trend in the frequency of thyroid disease became noticeable around 1942. Between the end of the war and the close of 1950 this had developed into an extensive epidemic, much more widespread and severe than that which occurred after the 1914-18 war. The following figures given by Ligdas are typical of many reports. They relate to schoolchildren in Dresden and other towns in that area of Saxony.

<table>
<thead>
<tr>
<th>School beginners</th>
<th>1948-49</th>
<th>1949-50</th>
<th>1950-51</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>9.1</td>
<td>11.9</td>
<td>14.4</td>
</tr>
<tr>
<td>Fourth-year scholars</td>
<td>8.7</td>
<td>19.1</td>
<td>19.8</td>
</tr>
<tr>
<td>&quot; Confrmands &quot;</td>
<td>11.6</td>
<td>19.0</td>
<td>22.6</td>
</tr>
<tr>
<td>Trades School</td>
<td>13.0</td>
<td>18.0</td>
<td>23.6</td>
</tr>
<tr>
<td>High School</td>
<td>12.2</td>
<td>16.2</td>
<td>22.8</td>
</tr>
<tr>
<td>Trades High School</td>
<td>16.2</td>
<td>20.4</td>
<td>37.7</td>
</tr>
</tbody>
</table>
These post-war goitre waves are due, as is apparent from many reports, to dietary deficiency during the war period. Proof of this is found in the fact that certain well-fed groups of people—for example, cooks, interpreters and occupying troops—escaped the goitre wave. This is also borne out by Haubold's investigation of schoolchildren in Bavaria, where the goitre rate rose to 42%, while only 9% of children in occupying American families were affected.

Arguments have been advanced by Haubold that the specific dietary deficiency responsible for the post-war goitre wave is a decreased intake of vitamin A and carotene. His goitre surveys in the Weilheim district of Upper Bavaria show that in villages where the vitamin-A and carotene contents of butter and herbage are exceedingly low, the goitre rate is more than double that in villages where these dietary factors are substantially more plentiful. The goitres occurring under circumstances of vitamin-A deficiency are of the hyperthyroid type, and it has been shown by Bukatsch, Haubold & Lackner that treatment with vitamin A or carotene causes regression of the goitre and amelioration of the signs of hyperthyroidism.

On the other hand, Ligdas maintains that, in spite of the interesting observations by Haubold, deficiency of iodine in natural form remains the factor chiefly responsible for the post-war goitre waves. At the beginning of the Second World War the German people were consuming an average of 12 kg of sea-fish per head per annum. During the first five years following the end of the war the people hardly ever saw sea-fish at all, according to Ligdas. The connexion between agricultural food production and the occurrence of goitre among schoolchildren in the Berlin area has been examined in detail by Habermann in an excellent series of papers.

In the years between the two wars, prophylaxis by iodized salt, "Vollsalz" as it is called in Germany, had been tried in many areas; but owing to the fear of possible harmful effects (now known to be without foundation) more propaganda against the use of iodized salt has been advanced in Germany than in any other country in the world. Gloel, Medical Officer of Health at Landsberg in Bavaria, reported in 1934 that as a result of the almost exclusive use of iodized salt a strong, healthy, non-goitrous generation was growing up in the goitrous districts of Bavaria, notably at Kempten. He deplored the fact that in his own district the practice had been abandoned for fear of iodine poisoning. Where iodized salt had been in general use since 1924, Gloel did not find a single case of thyroid enlargement among pupils of a school he inspected in 1930. Four years later, however, owing to the withdrawal of iodized salt, 75% of the children in the same school were suffering from thyroid enlargement. He also records that provincial teachers had noticed a corresponding decline in the average intellectual capacity of children beginning school life.
Today the situation in southern Bavaria is little better than in 1934, and a strong plea for the re-introduction of iodized salt has recently been made by Bauer. In co-operation with five medical colleagues he examined a total of 45,818 schoolchildren in the localities of Miesbach, Chiemgau, Traunstein, Berchtesgaden, Pfarrkirchen and Donauwörth, and was "shocked" to find goitre rates of 80% and even more in some places. In the Donauwörth area, for example, 93% of young people in Egelstetten had goitre, 61% in Ellgau, and 77% in Genderkingen, while Donauwörth itself, with 23%, was relatively immune.

Hundreds of papers have been written about goitre in Germany. Entries 573 to 628 in the bibliography at the end of this chapter are selected as dealing more especially with distribution and prevalence.

Switzerland

Endemic goitre has long been a serious health problem in Switzerland. Practically all parts of the country are prone to the disease, and in many localities it is markedly associated with mental deficiency, deaf-mutism and other disorders. Indeed, the burden of cretinism has been a heavy charge on public funds. In 1923 the Canton of Bern alone, with a population of little more than 700,000, had to hospitalize 700 cretins incapable of any social life.

Cantons where the incidence has always been high are Aargau, Zurich, Schaffhausen and Thurgau in the north; Appenzell, St. Gallen and Graubünden in the east; Bern, Luzern and Uri in the centre; and Fribourg and Valais in the south-west. There is less goitre in the north-western cantons, Basel, Solothurn and Neuchâtel.

Thanks, however, to the official encouragement given to the general use of iodized salt the situation has greatly improved in recent years. Goitre rates have fallen steeply and deaf-and-dumb institutions have been closed or diverted to other purposes (Wespi 875, 878). Recruitment statistics provide unmistakable evidence of this downward trend. Table VII (Schaub 868)

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of men examined</th>
<th>Number of men exempt on account of goitre</th>
<th>Number of goitres per 1000</th>
</tr>
</thead>
<tbody>
<tr>
<td>1903</td>
<td>26,283</td>
<td>2,451</td>
<td>93.2</td>
</tr>
<tr>
<td>1905</td>
<td>28,448</td>
<td>3,093</td>
<td>116.9</td>
</tr>
<tr>
<td>1914-18</td>
<td>151,106</td>
<td>3,403</td>
<td>22.5</td>
</tr>
<tr>
<td>1921</td>
<td>32,838</td>
<td>1,817</td>
<td>55.3</td>
</tr>
<tr>
<td>1925</td>
<td>39,681</td>
<td>1,229</td>
<td>30.9</td>
</tr>
<tr>
<td>1935</td>
<td>29,627</td>
<td>338</td>
<td>11.4</td>
</tr>
<tr>
<td>1939-45</td>
<td>228,101</td>
<td>340</td>
<td>1.5</td>
</tr>
<tr>
<td>1945</td>
<td>31,654</td>
<td>21</td>
<td>0.6</td>
</tr>
<tr>
<td>1947</td>
<td>31,366</td>
<td>23</td>
<td>0.7</td>
</tr>
</tbody>
</table>
shows that between the years 1925 and 1947 the number of exemptions from military service on account of goitre fell from 31 per thousand to less than 1 per thousand. The recession began with the introduction of iodized salt in the early 1920's and has been maintained ever since.

The same decline is seen in the goitre statistics relating to young people. For example, an examination in 1937 of schoolchildren in the Canton of Valais—a region particularly affected—gave the results shown in Table VIII (Bayard 629).

**TABLE VIII. INCIDENCE OF GOITRE AMONG SCHOOLCHILDREN IN THE CANTON OF VALAIS**

<table>
<thead>
<tr>
<th>Period</th>
<th>Normal thyroids (%)</th>
<th>Palpable thyroids (%)</th>
<th>Enlarged neck (%)</th>
<th>Pronounced goitres (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1920 (Before introduction of iodized salt)</td>
<td>28.8</td>
<td>54.3</td>
<td>14.9</td>
<td>2.0</td>
</tr>
<tr>
<td>1934 (Ten years after introduction of iodized salt in 1924)</td>
<td>70.5</td>
<td>27.3</td>
<td>2.1</td>
<td>0.15</td>
</tr>
</tbody>
</table>

At three towns in the valley of the Broye, a singularly goitrous area of the Canton of Vaud, where 20% to 40% of conscripts were usually rejected, Messerli 653 has shown that between 1921 and 1951 thyroid enlargement in children has very greatly decreased. The statistics are as follows; they should be considered in the light of the fact that since 1924 100% of all salt consumed by the people throughout the Canton of Vaud has been iodized.

<table>
<thead>
<tr>
<th>Locality</th>
<th>Goitre rate (%) 1921</th>
<th>Goitre rate (%) 1937</th>
<th>Goitre rate (%) 1951</th>
</tr>
</thead>
<tbody>
<tr>
<td>Avenches</td>
<td>78.9</td>
<td>24.1</td>
<td>7.1</td>
</tr>
<tr>
<td>Payerne</td>
<td>78.0</td>
<td>22.4</td>
<td>4.0</td>
</tr>
<tr>
<td>Moudon</td>
<td>73.5</td>
<td>18.3</td>
<td>4.9</td>
</tr>
</tbody>
</table>

Similar results have been obtained from many different parts of Switzerland, and all responsible investigators agree that the descending curve of incidence can be correlated with the period over which supplementary iodine has been introduced into the diet of the population. The sale of salt is not a federal but a cantonal matter, in accordance with the salt laws of individual cantons. Accordingly, the introduction of iodized salt has differed markedly from canton to canton, both in point of time and in regard to the quantity sold. Goitre statistics coincide precisely with these facts. Thus, the reduction in the number of conscripts rejected on account of goitre begins much earlier in those cantons which introduced prophylaxis in the years 1922, 1923 or 1924 than in those which did not introduce it until 1929 or 1930. Furthermore, as is evident from the statistics shown in
TABLE IX. RELATION BETWEEN CONSUMPTION OF IODIZED SALT AND REJECTION OF ARMY RECRUITS ON ACCOUNT OF GOITRE

<table>
<thead>
<tr>
<th>Cantons *</th>
<th>Average consumption of iodized salt per canton, expressed as a percentage of total salt consumed</th>
<th>Average number of rejections on account of goitre, per 1000 recruits called up</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 to 9</td>
<td>Nil **</td>
<td>75.3</td>
</tr>
<tr>
<td>10 to 17</td>
<td>Nil</td>
<td>30.0</td>
</tr>
<tr>
<td>18 to 25</td>
<td>Nil</td>
<td>8.5</td>
</tr>
</tbody>
</table>

* 1 to 9: Nidwalden, Vaud, Zug, Schaffhausen, Schwyz, Obwalden, Valais, Neuchâtel, and Appenzell Ausser-Rhoden
10 to 17: Ticino, Glarus, Uri, Appenzell Inner-Rhoden, St-Gallen, Geneva, Graubünden, and Thurgau
18 to 25: Zurich, Bern, Luzern, Fribourg. Solothurn, Basel-Stadt, Basel-Land, and Aargau

** The single exception is the Canton of Appenzell Ausser-Rhoden, where iodized salt was introduced in 1922.

Table IX (Schaub 665), the magnitude of the reduction is directly parallel to the absolute amount of iodized salt consumed.

In his assessment of the results of goitre prophylaxis in Switzerland published by the World Health Organization in 1953, Nicod 657 remarks that the only canton which has almost entirely resisted the use of iodized salt, that of Aargau, is the one which still rejects the largest number of young people on account of goitre. Nicod's later review 658 (1957) of the progress of goitre prevention by iodized salt in Switzerland re-emphasizes emphatically its effectiveness and safety.

The dental caries problem in Switzerland has prompted Wespi and his colleague Egenberger 678, 677, 680 to recommend the manufacture and distribution of a dual-purpose salt enriched with 200 mg of sodium fluoride and 10 mg of potassium iodide per kilogram of salt.

The literature on Swiss goitre is extensive; in the bibliography at the end of this chapter, only a few of the more important epidemiological studies are cited. 629-882

Italy, Sicily and Sardinia

The many descriptions of goitre and cretinism to be found in the classics and in Italian literature of the Middle Ages show that thyroid disease has been a problem in Italy from earliest times. Indeed, its seriousness and persistence into the nineteenth century prompted one of the first and most competent goitre surveys ever made under government auspices. This was the Commission of nineteen members appointed in 1845 by King Carlo Alberto of Sardinia to investigate the extent, nature and causes of the disease throughout his Kingdom, which in those days comprised the provinces of Savoy, Nice, Piedmont, Genoa and the island of Sardinia. 771
Modern reviews of the goitre problem in Italy have been undertaken by Ciocchi\textsuperscript{705-707} and by Costa and his school,\textsuperscript{710-717} both of whom refer particularly to the outbreaks of acute goitre that occurred in Piedmont during the war years of 1940-1945. According to Costa & Mortara,\textsuperscript{712} endemic goitre, widespread in the last century and in the first decade of the present, subsequently began decreasing in the north of Italy while increasing somewhat in central and southern parts of the country. About 20 years ago, however, the phenomenon of epidemic goitre made its appearance in the north; this has given rise to much research to determine its cause and its relationship to the endemic type. In Costa’s view, the endemic noxa in Italy cannot be identified with goitrogenic factors or iodine deficiency in local foods and waters; no substantial differences have been shown between endemic and non-endemic areas.

Cerletti\textsuperscript{702} is convinced that even today five million people in Italy (i.e., 10\% of the population) are affected by thyroid disease. The literature of Italian goitre, of which we cite 100 papers,\textsuperscript{683-782} is certainly the most extensive of any country in the world.

Geographically, the endemic occurs to a varying degree throughout the whole of the Alpine region in the north of the country, in a semi-circular belt extending from the Ligurian Alps through Piedmont, Lombardia and Trentino to Venezia in the east. The disease is found not only in the upland valleys, but also in the plains north and south of the river Po, although to a much smaller extent.

In the Region of Piedmont, intensively studied by Cerruti\textsuperscript{741} and by Mortara,\textsuperscript{748} the places particularly affected are, first, the towns of Cuneo and Saluzzo, where outbreaks of acute goitre occurred among troops in 1940-41 (Anglesio\textsuperscript{686}). Children from various schools in the districts of Cuneo, Saluzzo and Alessandria were recently (1957) examined by Mortara & Martinetti\textsuperscript{751} who found that the disease still affects the rising generation in these places. Farther north are the district of Aosta and the valley of the Dora Baltea at the foot of Mont Blanc, long a noted centre. It has been surveyed fully by Trikurakis\textsuperscript{776-778} and by Raggi & Marocco,\textsuperscript{767, 768} and was the focus of an outbreak described in 1948 by Vogliazzo & Forni.\textsuperscript{781} Nearby, is the Canavese region, the chief centre of which is Ivrea where acute forms of goitre in adults have been noted by Maggiorotti.\textsuperscript{740}

In this same general area goitre is seen at Vercelli and in the valleys of the Sesia and Ticino rivers. Also affected are the Province of Varese between Lakes Maggiore and Como; the town of Como itself; the valley of the river Adda and the mountains of Valtellina and Sondrio in the extreme north; the alpine hinterland of Bergamo and Brescia, including Breno and the valley of the Chiese; the valleys of the Peio, Sole and Rabbi west of the Trento-Bolzano axis; the Region of Trentino-Alto Adige (which includes the Dolomites); Valsugana; the neighbourhood of Belluno; the Carnic Alps and the district around Udine in Venezia-Giulia. Authorities
who have written especially about these regions are Pighini, Muggia, Fiorio, Cancellara, Paccagnella, and Turri. Their investigations indicate that in the area between the Alps and the river Po thyroid enlargement is found in 20%-30% of schoolchildren. In high mountain districts these figures may rise to 50%-60% and in certain communities may reach even 70%-80%. Indeed, rates of 100% are not unknown (Ambrosi).

In the great north-central plains thyroid disease is much less severe, but acute episodes do arise from time to time as, for instance, that recently described by Denes & Andreotti at Carmignano di Brenta, a municipality in the grape and cereal-growing country 9 miles north-east of Vicenza in Padua Province. Here, signs of thyroid enlargement were first noticed in 1947, attained their greatest severity by 1950, and then disappeared.

Apart from the main Alpine belt and the sporadic outbreaks in the northern plains, goitre also occurs in the Ligurian Apennines immediately north of Genoa (Bagnasco). A large number of places in the Etruscan Apennines due south of Modena are also affected. For instance, Mucci records rates of between 10% and 60% among boys and girls at Montese, Magreta, Guiglia, Mirandola and Riolunato. The etiology of acute goitre in the valleys of the Secchia and Dolo rivers has been investigated by Pighini & Gualdi; and Businco has described at length all the circumstances surrounding a goitre focus of unusual severity in the district of Sestola near Monte Cimone. Somewhat further south is the Province of Pistoia, where an epidemic of goitre in young people occurred in the war years 1941 to 1946 (Bizzarri). All sorts of theories have been advanced to account for this outbreak—nitrates and sulfur compounds in the water-supply, emotional factors due to war stress, and so on—but it seems that food deficiency during the period of emergency is the most likely cause.

In Tuscany, also, epidemic goitre has been noted by Naudi & Calamari in the region of Montespertoli, an upland village about 16 miles south-west of Florence. Clinical examination of the children led to the conclusion that an infection acting on a population in a state of nutritional deficiency and border-line thyroid adequacy was the cause. The most recent accounts of goitre in the Province of Florence are those by Magherini & Zecchi and Magherini et al. They examined 1756 children aged 6 to 14 years in the communes of Londa, San Godenza, Vicchio di Mugello, Pontassieve and Rignano sull'Arno, and found goitre rates varying from 36% in Londa to 70% in Rignano. Goitre was evident in 69 out of 97 mentally subnormal and in 77 out of 134 mentally normal children.

Due east of Florence towards the Adriatic coast, a centre of severe endemic goitre lying in the upper valley of the river Conca on the eastern slopes of Monte Carpegna has been minutely described by D'Alo. The affected area, which is horseshoe-shaped, is bounded by the Faggiola and San Paolo on the east, by Monteboagghina and the Carpegna massif on the south, and by Monte Palazzuolo and Costagrande on the west. The most
important inhabited centre in the locality is Montecerignone. Extreme poverty, malnutrition, wretched living conditions, and unhygienic ill-lit and badly ventilated houses are the unhappy lot of the people in this area.

Goitre is endemic in Umbria and throughout the Marches in central Italy, especially along the river Tenna in the Montegallo area and in other parts of the province of Ascoli Piceno (Scoccianti; 772 Balice; 688, 689 Pitzurra; 761 Pitzurra & Modolo; 764 Tarozzi 774).

In the west, the disease is known in the Latium uplands in the Viterbo area (but not in Viterbo itself) to the north of Rome (Cerletti 702) and at Giulianello in the parish of Cori to the south of Rome. This latter focus has been carefully studied by Di Porto & Antoniotti,727 who point out that the district is extremely volcanic and suggest that the prevalence of goitre may be due to an excess of silica in the local foods and waters, a theory in agreement with that of Trikurakis.778

Very high goitre rates (40%-80%) are reported by D’Amora 720 from villages in the Sorrento peninsula. At Lauro, a village in the uplands about 30 miles east of Naples, 9% of boys and girls between the ages of 5 and 14 years were found by Sainsbury 769 to have goitre. The main formation in the area is limestone and the water is deep spring with the low iodine content of 2.1-2.2 μg per litre. The dietary standards are poor and the consumption of fish negligible. On the opposite side of the country, goitre centres are found both on the sea-shore and in the hills of the Gargano peninsula (Cerletti 702). In Lucania thyroid enlargement is noticeable at several places, particularly in Potenza Province (Ambrosi; 683 Calbi; 697 Pitzurra & Ponzio; 765 Barbieri; 691 Pitzurra, Modolo & Mori 763). Throat measurement of elementary schoolchildren at Palazzo San Gervasio, a town lying between Canosa and Potenza, has enabled Cancellara 698 to calculate an index of thyroid enlargement which he finds useful for determining the incidence of thyroid disease in a given section of the population.

In the extreme south of Italy, a little-known area of endemic goitre has been described by Criscenti.718 This includes the districts of Savuci, Taverna and Maranise, in the Province of Catanzaro, where the people live very largely on chestnuts and rye, and where the soils are derived from granitic rocks and archaean crystalline schists. At Taverna 93% of schoolchildren were found to be sufferers; at Savuci the rate was 77%.

Foci of endemic goitre and cretinism in Sicily have been described by Coppola 708 who refers especially to Nicosia in the Province of Enna as a noted centre. A prevalence of 29% among schoolchildren in the municipality of Barcellona Pozzo di Gotto on the north-east seaboard was observed by Spadaro & Alfano 773 in 1955. Dental fluorosis was noticeable in a high percentage of the goitre carriers. A re-survey of the area by Previtera, Molino & Pagano 766 in 1958 revealed lower rates, due it is believed to improved water supply. In 1957, Tempestini 778 inspected 500 inhabitants of the village of Motta Camasta (Province of Messina); of these, 42% of
adults and 49% of children showed thyroid enlargement, and 58% of adults and 41% of children, dental fluorosis. No direct relationship between the two conditions could be established; the greatest severity of fluorosis was seen in people with no thyroid abnormality.

In Sardinia the prevalence of goitre among schoolchildren has been studied in the Province of Cagliari by Corda and by Desogus. In the middle-west of the country, goitre is endemic in the town of Santu Lussurgiu and its surroundings, but cretinism is unknown (Ferraris et al.).

At Sondrio and in the Valtellina goitre prophylaxis by iodized salt (1:50,000) had, by 1938, been in vogue for about fourteen years with good results (Lutirario; Ambrosi; Cerruti). In that time the number of cases showing obvious enlargement fell from 57% to 1.4%. Besides the general decrease in thyroid size there was a lowering of the infant-mortality rate and improved mental alertness among children. Iodine preventive measures have also been applied in the Valle d’Aosta by a committee set up by the public health authorities of the Region. Iodized chocolates, each containing 10 mg of potassium iodide, were distributed to schoolchildren at the rate of two per week, and in some schools open wide-mouthed bottles of tincture of iodine were exposed. Good results were obtained from the chocolate tablets, but no benefit followed the exposure of iodine tincture.

Malta

D. C. Wilson (personal communication, 1955) says she has seen goitre in Maltese people who come from the north and west of the island where the water-supply is derived from wells. It is of interest that waters obtained from waterworks in and around the centre of the island have a high iodine content, ranging from 21 μg to 40 μg per litre. Unfortunately, no comparative analytical figures are available for well waters from the north.

Spain

There is a great deal of goitre in Spain. Almost all mountainous districts are affected, some to a serious degree. Particulars of the distribution are derived from four principal sources: (1) the 1927 report of the Commission of Inquiry on Goitre, set up by the Spanish Government in 1921 under the direction of Marañón; (2) the long and important series of investigations (1947-56) conducted under the leadership of Ortiz de Landázuri of the Faculty of Medicine, Granada, and the Department for Goitre Prophylaxis, Board of Health; (3) the reports of the well-known Barcelona endocrinologist Cañadell, in collaboration with the Swiss investigators Eugster & Dieterle; and (4) the accounts of goitre in the Province of Sevilla by Rivero Fontán and co-workers. The history of goitre in Spain has been written by Greenwald who sheds
interesting light on reasons for the comparative rarity of the disease among Jews.

From data acquired by provincial health inspectors, Ortiz de Landázuri and his colleagues have prepared a map showing, by a system of crosses, the comparative intensity of the endemic in those provinces in which the disease chiefly occurs.\textsuperscript{788, 803} The indications are as follows (provinces not mentioned are those for which no data are given on the map):

| Northern Provinces | | Central Provinces | | Southern Provinces |
|--------------------|----------------|-------------------|-------------------|
| Lugo | ++ | Navarra | ++++ | |
| Oviedo | ++++ | Huesca | ++ | |
| Santander | ++ | Lèrida | + | |
| Vizcaya | ++ | Barcelona | ++ | |
| Pontevedra | + | Zaragoza | | |
| León | +++ | Tarragona | + | |
| Zamora | + | | | |
| Ávila | ++ | Guadalajara | +++ | |
| Madrid | + | Teruel | +++ | |
| Cáceres | ++++ | Albacete | + | |
| Cuenca | ++ | Castellón | + | |
| Badajoz | +++ | Valencia | ++++ | |
| Sevilla | ++ | Jaén | ++ | |
| Córdoba | + | Granada | ++++ | |
| Cádiz | + | Almería | + | |
| Málaga | ++ | | | |

In the north, a belt of very considerable intensity extends from Catalonia along the Pyrenees through the Cordillera Cantabrica and the Asturias to Galicia in the west. Tracing this in greater detail, we find goitre especially in the north-west of Gerona Province, where the regions of Ribas de Fresser and Camprodón provide many cases. In the neighbouring Province of Barcelona there is much goitre in the Montseny area, in the Llusánés valley and in the country to the north of Berga. Conditions here are described by Eugster & Dieterle\textsuperscript{786} as exceedingly reminiscent of those in the foothills of the Swiss Alps; indeed, the people call the district "pequeña Suiza" (little Switzerland). Incidence is highest in the deep intersecting valleys of the region, whereas the high tablelands are mostly free from the disease. Piulachs & Cañadell\textsuperscript{810} have prepared a detailed goitre map of this area, and representative photographs of the Montseny goitres have been published by Draper Alfara\textsuperscript{785}.

Moving westwards through Lèrida Province, we find considerable goitre in the Valle d'Arán. In Huesca, the northern valleys of the river Cinca and its tributaries are well known to be goitrous. From thence the endemic extends through the Provinces of Navarra and Vizcaya into Santander,
whence it spreads over the Asturias, Oviedo, León, and into the valleys of Galicia. In the extreme north-western section the endemic is less severe than in the high valleys of the Pyrenees between Spain and France where, in addition to simple goitre, there is a good deal of cretinism and deaf-mutism. Cretinism is also a strong feature in the Asturias—an area which, according to Marañón, has been studied in great detail by Goyanes and Ceníga. Here, numerous cases of goitre and cretinism occur near the sea as well as at higher levels.

In central Spain goitre is found along the Sierra Gredos lying to the south of Ávila Province west of Madrid. In this area the valleys of the head-waters of the rivers Tormes and Alberche are particularly affected, as also is the valley of the Tiétar where the endemic has been studied in some detail by Martín Lázaro. West of this towards the Portuguese border, goitre is exceedingly prevalent in the Sierra de Gata. Here, indeed, we find one of the most notorious goitre centres in the world—the region of Las Hurdes, a section of the Sierra de Gata covering the extreme northern tip of the Province of Cáceres.

Las Hurdes constitutes an incomparable field for the study of goitre. It is the most important focus in all Spain. The area, mapped by Pérez-Vitoria, is composed of three long narrow valleys of unbelievably rough and inhospitable country. The geological formation is exclusively of slate and has a sparse and unproductive vegetation. The prevalence of goitre exceeds 25% and large numbers of the goitrous population are also cretinoid. Cases of idiocy, deaf-mutism, infantilism and dwarfism are many, and not a single man from the district has been found fit for military service, either because of low stature or marked feeble-mindedness. The whole region is one of tragic aspect and has given rise to numerous legends—often exaggerated no doubt—in the records of ancient and modern travellers and national writers (Legendre; Marañón). Other goitre areas in central Spain lie in the east towards the Mediterranean; they include the Province of Castellón de la Plana particularly the mountains of the Alto Maestrazgo, and a large part of the Province of Valencia.

Southern Spain’s most goitrous province is Granada, where the region of Las Alpujarras on the southward slopes of the Sierra Nevada is highly affected and has been studied in detail by the school of Ortiz de Landázuri. Elsewhere in the south goitre is found in the north part of Sevilla in the neighbourhood of Constantina between the Guadalquivir and the Sierra Morena. Cases are also encountered in the Sierra de Algodonales between the Provinces of Sevilla and Cádiz, and in the Serranía de Ronda on the west border of Málaga Province.

The outcome of a great deal of experimental work in the University of Granada has convinced Ortiz de Landázuri and his colleagues that iodine deficiency is the main cause of goitre in the Granada area. This assumption is based on the extremely low iodine content of the drinking-
waters from affected districts\textsuperscript{786} and is confirmed by the fact that in the space of 16 months there was an over-all decrease in the goitre rate, from 60\% to 33\%, as a result of administering iodized salt (1: 50 000) in an area of extreme endemicity.\textsuperscript{788}

Most recent results (1959) of mass prophylaxis with iodized salt in Spain are those of Ibáñez González et al.\textsuperscript{789} whose data refer to the Alpujarras region of Granada. Applied to a population of 100 000 since February 1954 the general use of iodized salt has resulted in a progressive decrease in the goitre rate from 55\% in 1953 to 33\% in 1955 and 13\% in 1958. Neither administrative inconvenience nor any harmful secondary effects were encountered.

**Portugal**

The distribution of goitre in Portugal is best seen on the map published in 1950 following the national inquiry on endemic goitre instituted by the Director-General of Health.\textsuperscript{816} Although nowhere exceptionally severe, the disease is endemic or of frequent occurrence in the following districts:

*Northern Portugal.* Vinhais, Terras de Bouro, Mondim de Basto, Amarante, Penafiel, Baião, Castro Daire, and Sátão. Cretinism is seen in Vinhais and Amarante.

*Central Portugal.* To the east, the goitre belt of western Spain (Sierra de Gata) extends into the districts of Sabugal, Belmonte, Penamacor, Fundão, Castelo Branco, Oleiros, Proença-a-Nova, Mação, and Crato. On lower ground to the west, nearer the sea, goitre occurs in Miranda do Corvo, Anciã, and Castanheira de Pera.

Incidence is highest in the region of Castelo Branco; here goitres begin to develop in children of five or six years of age, whereas the great majority of cases in other parts of Portugal occur between puberty and the age of 50.

*South Portugal.* Goitre is seen in the neighbourhood of Montemor-o-Novo east of Lisbon, and there is a belt of mild incidence in the extreme south, covering the districts of Odemira, Ourique, Almodovar, Loulé and Tavira.

In common with other countries the disease occurs much more frequently in females than in males; it often appears in various members of the same family; but in only four sufferers was it found to be associated with deaf-mutism. Goitre is known by several different words in Portugal. Bócio is the medical term, but ordinarily it is called papeira or papo; other familiar names are garganta, lobo and papada. Organic debility, emotional disturbances, prolonged anxiety, and peculiar qualities of soil and water are some of the factors to which goitre is attributed. There is a popular notion in Ourique that the disease is caused by drinking water that has passed over the roots of a fig-tree.
Western Europe

Belgium

It seems to be generally agreed that goitre is not an outstanding problem in Belgium today, although there are earlier reports of its endemic occurrence in some of the high-lying southern districts towards the Ardennes and Luxembourg. The comparative absence of goitre goes hand in hand with Clinquart's observation that drinking-waters in Belgium contain more iodine than those in Switzerland.

During the 1939-45 war, however, Brull first drew attention to a changing incidence of thyroid disease in Belgium. He found that the basic metabolic rate of all goitre cases seen at his clinic in Liège showed a steady decline from an average figure of −21.9% in 1939 to +6.6% in 1942. This was confirmed by Bastenie who, in comparing the number and severity of cases of thyroid disease observed at the St. Pierre Hospital, Brussels, in the years before and during the German occupation, found that whereas the incidence and severity of hyperthyroidism did not increase and may probably have decreased, there was a significant increase in the incidence of simple goitre at all ages but particularly in the age-group 15-25 years.

The observed changes in incidence and severity are thought to be related to the quantity and quality of the diet, especially the wartime increase in the consumption of cabbage and related vegetables which contain substances of the thiourea group. In this connexion it has been pointed out that if the increase in simple goitre in Belgium during the war was in fact comparable to the "cabbage" or "rape-seed" goitre of animal experiments, a reduction in severity might be expected in cases of toxic goitre on the same diet. Such patients would, in effect, be treating themselves on the most modern lines. If this is the correct explanation it leaves open the possibility that there was an actual increase in thyrotoxicosis in Belgium during the war, which was masked because the population was being simultaneously dosed with thiourea compounds taken in the diet.

The latest study of the distribution and frequency of goitre in Belgium is that by Brull & Dewart who examined 54,000 army recruits. Of these, only 1.3% showed thyroid enlargement at enlistment; and most of the cases were simple hypertrophy without either toxic or hypothyroid symptoms. Frequency increased from the coast to the east and south of the country, i.e., towards the higher areas of La Fagne, the Ardennes, and Luxembourg.

England and Wales

In his Treatise on English Bronchocele, Inglis says that at one time goitre was as common in the Yorkshire dales as in Geneva or any of the Alpine valleys. Children could be seen at play with pieces of black velvet tied around their necks—a superstition to ward off the goitre evil or charm it away.
The red hatching indicates the areas where endemic goitre has been found.
Other records in the early medical history of English counties show that goitre and cretinism were prevalent in Norfolk, in the Manchester area, in Monmouthshire, in Cornwall and elsewhere. There was a strong endemic centre in Weardale in the west of Durham, and cretins were notorious at Chiselborough in Somerset. A local predilection for oatmeal cakes was believed to be responsible for goitre in Matlock. And to this day the synonym “Derbyshire neck” brands that county as goitrous—albeit unfairly, for goitre has always been equally severe, if not more so, in Oxfordshire, Gloucestershire, Somerset and Dorset.

The first connected account of the geographical distribution of goitre in England is that by Berry, who found thyroid enlargement moderately prevalent in the south-east of England, particularly in the Wealden area of Sussex and on the high ground around Horsham and towards Haslemere in Surrey. To the west and south-west the disease was conspicuous in Gloucestershire and in east and south Somerset. There was a distinct seat of occurrence in the Warwickshire villages south of Leamington. Farther east, a centre existed in Bedfordshire and there was evidence of goitre in Buckinghamshire and Hertfordshire. In the midlands a considerable number of goitrous people were noticed in Staffordshire, Lancashire and Derbyshire. From thence Berry traced the goitre belt northwards through Yorkshire to the junction of west Durham, Northumberland and Cumberland where there was a well-known endemic focus at the lead-mine district of Alston and the adjoining area of Weardale.

A comprehensive all-England examination of 375,000 schoolchildren undertaken by the medical department of the Board of Education in 1924 not only confirmed the goitrous areas delineated by Berry a quarter of a century earlier, but disclosed a trend of goitre incidence sufficiently disquieting to prompt the first official recommendation that “prophylactic administration of iodine to girls in some endemic areas of England and Wales might be desirable”. The over-all goitre rate revealed by the 1924 survey among schoolchildren of 12 years of age was 5.26% in boys and 13.33% in girls in areas of high prevalence, and 1.49% in boys and 4.41% in girls in the areas of low prevalence. But some places—notably, in Devon, Somerset, Oxfordshire, Northumberland and Durham—had goitre rates of 10% to 20% among boys and more than 30% among girls.

The prophylactic administration of iodine recommended by the 1924 survey was never given general effect; but during the inter-war years some attempt was made to introduce iodized chocolate and sweets in a few affected localities. These measures, however, depended too much on the unaided efforts and enthusiasm of individual public health officials and consequently lacked the continuity which support from a central authority alone can ensure.

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Without doubt the prevalence of goitre in England has considerably diminished over the past hundred years in consequence of rising standards of public hygiene, better food and improved water-supplies; but the disease has never been entirely extinguished and has always continued to disturb the minds of research groups and organizations anxious to improve the physique and health of the people. In the year 1936, in the County of Somerset, goitre rates of 36% were still the rule among schoolgirls living in the neighbourhood of Taunton, Yeovil and Wells; and in 1940 urgent attention was being drawn in the medical press to the high incidence of goitre persisting throughout South Wales.

The war of 1939-45 brought the subject into a new prominence because of reports that thyroid enlargement was increasing in areas cut off from supplies of sea-fish. It was also noticed that the condition was unusually common among young women drafted into factories for war work. The Medical Research Council of Great Britain thereupon appointed a committee to consider these observations and to carry out special surveys of certain sections of the population in several counties of England and in two in Scotland. Among the committee's findings were: established goitre in 50% of adult women at Hook Norton, Oxfordshire; thyroid enlargement in 43% of girls at Sherborne in Dorset; in 26% of boys and girls at Okehampton in Devonshire; and in 21% of girls at St. Albans, Hertfordshire. By contrast, only 2% of children showed thyroid enlargement at Maldon in Essex where the drinking-water is rich in iodine.

In short, the areas in which official surveys have located evidence of iodine deficiency in England are the same today as they were 50 or 100 years ago. At the time of their investigation (1944) the Goitre Subcommittee of the Medical Research Council estimated that in England and Wales there were some 500,000 cases of thyroid enlargement in persons of ages 5 to 20 years inclusive. There is no reason to suppose that this figure is any less today, 12 years later; indeed, the following comparatively recent reports suggest the very opposite. Lisney, County Medical Officer of Health, Dorset, refers to a surprising increase in thyroid enlargement coupled with increased lassitude and anaemia among women seen at the Dorchester ante-natal clinic in 1949 compared with previous years. Similarly, Simpson reports thyroid enlargement linked with real ill-health, lassitude and catarrh among expectant mothers attending her ante-natal clinics in the Isle of Wight during 1951. Cooke also describes a symptom-complex among women in West Hartlepool which responds to thyroid medication and is believed to be analogous to, if not identical with, the Roberton syndrome commonly met with in Christchurch, New Zealand. This involves lassitude, coldness, and hair changes following pregnancy, and is regarded as a condition of hypothyroidism associated with endemic goitre. Hoey reports a high incidence of goitre in the Bedwellty area of Monmouthshire, particularly in Aberbargoed and New Tredegar. He recommends the
compulsory use of iodized salt and suggests that it would possibly be helpful to make thyroid disease notifiable. The prevalence of goitre in two contrasted South Wales communities (Rhondda Fach and the Vale of Glamorgan) has been studied by Cochrane & Miall, with the assistance of W. R. Trotter.

Schools of north Oxfordshire in which the Medical Research Council team recorded high goitre rates in 1944-48 were re-examined in 1958 by the same clinical methods and classification. The area in question lies on a belt of limestone and marl extending through the county from Witney to Banbury. Hughes, Rodgers & Wilson, who undertook the second survey, found that the previous rate of 26.9% in girls had significantly increased to 40.4%. No significant change was found in the rate for boys; this remained at 14.8%.

The iodine level in milk from farms in north Oxfordshire was compared with that of milk from farms in Wales and Essex; no significant difference was found. It is suggestive, however, that the water drunk by cows in non-goitrous Essex contained from 18-117 μg of iodine per litre whereas in Oxfordshire and Wales, both of goitrous tendency, the corresponding values were 1.7-5.3 μg per litre and 2.2-2.9 μg per litre, respectively.

In 1944 and again in 1948 the Goitre Subcommittee of the Medical Research Council urged the general adoption of iodized salt throughout the United Kingdom as a means of preventing goitre. The level recommended is 1 part of potassium iodide in 100 000 parts of all salt, or 1 part in 40 000 parts if only packeted table salt is to be iodized. In 1950 the Government of the day seemed disposed to fulfil this recommendation; but no action followed. All that has been sanctioned and carried into effect is the addition of potassium iodide to the vitamin tablets issued by the Ministry of Health to expectant and nursing mothers.

Scotland

The survey by the Medical Research Council mentioned in the section on England and Wales confirmed the well-known fact that the content of iodine in drinking-water is a determining factor in the distribution of endemic goitre. Even more important, however, was the finding that an iodine level which in a soft water may be adequate to prevent goitre may be insufficient where the water is hard. This explains why in Scotland, where the waters are mainly soft, goitre appears at a lower level of iodine intake and is much less prevalent than in England, where the waters are mainly hard.

Although goitre is not a common disease in Scotland there are nevertheless some areas where it is prone to occur, namely, in the Southern Uplands and in parts of Inverness-shire. At one time the affected region in the south extended over the greater part of Roxburghshire, the west of
Berwickshire, the upper parts of Selkirk and Peebles, the northern districts of Lanarkshire, the eastern side of Ayrshire, the whole of Dumfriesshire and Kirkcudbrightshire, and the eastern parishes of Wigtownshire. Today, goitre has largely disappeared from these counties with the exception perhaps of Dumfriesshire, where the valleys of the rivers Esk, Annan and Nith remain distinctly suspect areas. The rates of thyroid enlargement found among boys and girls in the 1948 survey of the Medical Research Council were: 19% at Kirkconnel in upper Nithsdale, 20% at Langholm, 23% in the Burgh of Lockerbie, and 17% in the Burgh of Dumfries.

In Inverness-shire a considerable amount of thyroid enlargement has been found among schoolchildren at Fort William, at Kingussie, in the Burgh of Inverness itself, and in Glen Urquhart, where the rates were particularly high, 35% in boys and 47% in girls.

Elsewhere in Scotland goitre is of little account nowadays, but to complete the record it should be mentioned that in earlier times there were goitre centres in Perthshire, in the Isle of Arran, around Wishaw, in the valleys of the western tributaries of the Clyde, especially in the coalmining district of Larkhall, and in and near Fauldhouse midway between Edinburgh and Glasgow on the east side of the Forth-Clyde watershed. Goitre is also said to have occurred at one time on the east coast of Fifeshire.

A fairly recent study has been made by Keddie of the distribution of congenital deaf-mutism in Scotland. He states that 928 congenital deaf-mutes attended schools for the deaf in Scotland during the 20 years 1924-44, but the records of the districts from which these children came reveal nothing to suggest that deaf-mutism is invariably confined to the goitre areas.

Northern Ireland

During the course of routine medical examination of people from Northern Ireland applying for visas to enter the USA in 1929-30, Olesen & NcAl found a surprising amount of simple goitre among individuals coming from all parts of the six counties of Ulster.

In all, they examined 4648 males and 3992 females ranging in age from a few weeks to more than 80 years. The rate of indisputable thyroid enlargement among the males was 11.8% and among the females 27.4%. In both sexes the greatest amount of goitre was found between the ages of 15 and 24 years, the percentage being highest (33.1) in girls of 15 to 19 years.

More recent investigations have been made by Erskine, who determined the goitre rate in children attending public elementary schools in the south of County Antrim. Here, the goitre areas are typical rural districts with some small towns and villages situated on the main roads and

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* Long ago Mitchell gave the disease the local name of "Nithsdale neck."
near the sea coast. They extend from Waterfoot near Cushendall in the north, to Derrycrone in the extreme south of the County and are bounded on the north by the Atlantic Ocean and the North Channel, on the east by Belfast Lough, on the south by the city of Belfast and the river Lagan, on the west by Lough Neagh, and on the north-west by the Ballymena region of the County. The type of country varies considerably. On the north-east is a coastline of steep escarpments rising from the sea; inland a great plateau slopes down to a low-lying area on the west covered by flat bog or deposits of glacial clays and gravels.

Compared with other countries, the average goitre rate in Northern Ireland is not high. In every 1000 children examined, Erskine found 39 cases, of which 26 were in girls and 13 in boys. She saw more thyroid enlargement in rural than in urban schools and seldom found a case among sea-coast communities. Although the over-all rate averaged only 3.9%, there were some individual schools on the west plateau and in the valleys sloping towards Lough Neagh where the rate reached anything from 9% to 25%.

Faulty diet, iodine deficiency, bad hygiene and poor housing are the causes of goitre in County Antrim, according to Erskine. Focal and general infections are commoner in goitrous than in normal children; and the adverse effect which the condition has on the health of women during pregnancy and at childbirth is particularly noticeable.

Ireland

The general impressions of those competent to judge are that goitre is obviously much commoner in Ireland than in England. The area of highest endemicity is the South Riding of County Tipperary, but the disease is also known in County Dublin, County Wicklow, County Meath, and in Kilkenny 910 (also I. Brady and T. Stallard—personal communications, 1955). Cases have been recorded in an orphanage in Sligo (M. Kirby—personal communication, 1950) and there is a slight incidence in Counties Leix and Mayo. Goitre is said to be unknown in Galway and Kerry.911

The high prevalence in South Tipperary has been the subject of study by the Medical Research Council of Ireland over a period of years, and the results of their investigations are to be found in papers by O'Shea,911 Naughten,908 and O'Donovan.910 Data (see Table X) were accumulated from clinical examination of schoolchildren and chemical determination of the iodine content of the local dietary, soils and waters, not only in South Tipperary but, for comparison, in the non-goitrous sea-coast village of Spiddal in Galway, and in Port Laoighise (Maryborough) and Claremorris, two localities of intermediate goitre incidence.

These data show clearly how goitre is most prevalent where there is least iodine in the locally produced foods---milk, soda-bread and potatoes. The outstandingly high iodine content of soil and water in the coastal
TABLE X. RELATION BETWEEN OCCURRENCE OF GOITRE IN SCHOOLCHILDREN AND IODINE CONTENT OF SOILS, FOODS, AND WATER

<table>
<thead>
<tr>
<th>Place</th>
<th>County</th>
<th>Goitre in children (%)</th>
<th>Iodine content (µg per 100 g) of</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>soils</td>
</tr>
<tr>
<td>Cloran</td>
<td>Tipperary</td>
<td>65</td>
<td>3721</td>
</tr>
<tr>
<td>Kilsheelan</td>
<td>&quot;</td>
<td>70</td>
<td>3809</td>
</tr>
<tr>
<td>Tipperary town</td>
<td>&quot;</td>
<td>65</td>
<td>3071</td>
</tr>
<tr>
<td>Maryborough</td>
<td>Leix</td>
<td>40</td>
<td>3010</td>
</tr>
<tr>
<td>Claremorris</td>
<td>Mayo</td>
<td>10</td>
<td>5050</td>
</tr>
<tr>
<td>Spiddal</td>
<td>Galway</td>
<td>0</td>
<td>14390</td>
</tr>
</tbody>
</table>

district of Spiddal corresponds with high iodine in the local foods, and entire absence of goitre.

There is no law compelling people to use iodized salt in Ireland, but the public health authorities encourage its use throughout the whole country and particularly in the areas where goitre is known to be prevalent.

France

The geographical distribution of goitre in France is the same today as it has been throughout the past century, although during that time the intensity of the disease has much decreased (Mayet; 941-944 Rochaix 948).

The principal zones are: an eastern belt extending along the entire German-Swiss-Italian frontier from northern Alsace to the Alpes-Maritimes on the Mediterranean coast; a south-central zone covering the Auvergne and Massif Central; and a strong but smaller belt along the Pyrenees and Spanish frontier. Isolated from these three main areas are foci in the Departments of Aisne and Orne in the north-west. Excluding the two last-named, the districts of greatest incidence may be conveniently listed thus:

**North-eastern Zone**
- Moselle
- Vosges
- Haute-Saône
- Bas-Rhin
- Haut-Rhin
- Doubs

**South-eastern Zone**
- Jura
- Ain
- Isère
- Drôme
- Vaucluse
- Haute-Savoie
- Savoie
- Hautes-Alpes
- Basses-Alpes
- Alpes-Maritimes
South-Central Zone

Puy-de-Dôme  Saône-et-Loire
Corrèze  Loire
Cantal  Rhône
Lot  Haute-Loire
Aveyron  Ardèche
Lozère  Gard

Pyrenees Zone

Landes  Haute-Garonne
Basses-Pyrénées  Ariège
Hautes-Pyrénées  Pyrénées-orientales

In the eastern zone the heaviest intensity lies in Savoy, where the Tarentaise and Maurienne ranges are intersected by many goitrous valleys. Bérard & Dunet\(^{918}\) regard water as the essential etiological agency in this area and they point to the existence of "conscripts' springs", where recruits used to go to drink the water in order to develop neck swelling and so escape military service. They recall, too, the boarding-school at St. Jean-de-Maurienne where the pupils developed goitres during term but lost them when on holiday out of this area, only to develop them again on returning to school. "Holiday goitre" also develops rapidly in individuals from other parts of the country who choose to spend their vacation in these goitrogenic districts. To the south, goitre persists in the valleys of the Maritime Alps, more particularly along the rivers Vésubie and Bevera (Marot\(^ {939}\)).

North of the Savoy mountains the endemic stream follows a course along the Jura and Vosges whence it swings to the north-west over the Moselle country and through the Ardennes into the northern Paris plain. In Alsace the high ground on either side of the Rhine is affected; but the valley between, especially in the neighbourhood of Strasbourg, is goitre-free (Rhein\(^ {947}\)).

Of the south-central area covering the Auvergne mountains and extending eastward to the Cévennes and westward to the plain of Aquitaine, there is little to be said except that compared with former times the intensity of the endemic here has greatly decreased in recent years (Bérard & Dunet\(^ {918}\)). A series of fairly recent papers by Faugère, Vichnevsky, Laroche, Trémollières and Derache define the present goitre position in the Departments of Corrèze and Lot, which lie in this general area.\(^ {927}, 927, 928, 931, 952\) In both these departments goitre rates of 40% to 50% are to be found among schoolchildren of ages between 7 and 18 years.

In the Pyrenees, also, goitre is on the wane according to Rochaix.\(^ {948}\) It has not, however, completely disappeared and what seem to be almost permanent foci still exist in the canton of Luz-Saint-Sauveur, in the valley of the Adour south of Bagnères-de-Bigorre, and in the valleys of the Neste and the Aure (Gleizes & Boy);\(^ {930}, 931\) Marot\(^ {939}\).

Since the intensity of goitre is automatically diminishing with improved conditions of sanitation, and especially of water-supply and nutrition,
preventive measures as practised in other countries have never been con-
sidered necessary by public health authorities in France.

Records of goitre among domestic animals are occasionally met with in French veterinary literature. As long ago as 1862 Baillarger \textsuperscript{916, 917} described occurrences among mules, horses and dogs in the mountainous eastern regions of the country. More recently (1940), Jacob \textsuperscript{933} writes of thyroid disease of hyperthyroid type in foals born in the Breton coastal region north of Brest.

Goitre is not considered to be endemic in Corsica; nevertheless, cases are by no means infrequent in upland villages (Marot \textsuperscript{939}).

**PART II—AFRICA, ASIA AND OCEANIA**

**Africa**

Isidor Greenwald,\textsuperscript{956} the well-known goitre historian, has accumulated what he regards as compelling evidence that goitre, now endemic throughout most of Africa, was unknown in ancient Egypt or in Roman North Africa and, indeed, did not originate anywhere on the African continent until the nineteenth or even the twentieth century.

Nevertheless, there are several early accounts of its existence. Johannes Leo \textsuperscript{965} (c. 1494-1552), usually known as Leo Africanus, an Italian of noble Moorish stock and long ranked as the best authority on Mohammedan Africa, records in his Descrittione dell'Africa having seen goitre during his travels (1513-15) through Morocco and the Sahara. This account has been supplemented by a number of later observations which confirm that in North Africa goitre has long been endemic on the slopes and in the valleys of the Atlas Mountains, in Spanish Morocco, and in the Kabylia Mountains in Algeria.

When making his way from the Gambia to the upper waters of the Niger in 1795-96, Mungo Park \textsuperscript{980} saw goitre among the native peoples in the Bambuk country and at Segu-Sikoro in the direction of Timbuktu. The first European to reach Timbuktu from Tripoli, A. G. Laing,\textsuperscript{986} also mentions goitre in the narrative of his West African journeys (1822) when endeavouring to reach the source of the Niger through the interior of Sierra Leone.

The histological and other characteristics of goitres found among North African immigrants in the Lyons region of France are described in detail by Guinet & Berger.\textsuperscript{957}

**Algeria**

Some of the goitrous localities in eastern Algeria are mapped in a short paper by Sergent \textsuperscript{986} published in 1912. He refers to the calcareous nature of the terrain and mentions the regional names given to the disease—
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namely, Handjoura (Arabic); Hazzouza at Thaourirth-naith-gana; Aghbal at El-Kseur; Arkoun at Tizi-Ouzou; and Akerkour at Lafeyete.

The fullest and most recent studies are those in 1955 by Vergoz, Boulard & Bernard, and in 1959 by Vergoz & Sicard. They have mapped the endemic area and found it much more extensive than that traced by Sergent in 1912. It seems that the most seriously affected area is the Department of Constantine on the eastern side of the country where the disease is found throughout practically the whole of Little Kabylia from the interior to the sea coast. Goitre centres particularly noticeable in this zone are Collo, Philippville, El Milia, Taher, Djidjelli, Akbou, La Soummam, Bougie, Guergour, Takitount and Oued Amizour.

The goitre belt continues westwards into Grand Kabylia in the Department of Algiers where comparatively high rates are seen at Tigzirt, Tizi-Ouzou, Michelet, Boghni, Dra-el-Mizan, Palestro, Ménerville, le Fondouk, Rovigo, and Souma. This section of the endemic terminates at Blida, just south of Algiers. The city of Algiers itself is immune. Farther to the west there are one or two places on the coast, notably Gouraya and Montenotte, where the prevalence, although lower than in Kabylia, is still disquietingly high.

Oran, to the west of the country, is the least goitrous of the three main northern divisions of Algeria. The only place where the disease has been noted up to the present is the neighbourhood of Nedroma, which lies near the Moroccan border just south of Nemours.

The inquiry by Vergoz, Boulard & Bernard took account of about 40,000 persons—schoolchildren, military recruits, hospital patients and others—of whom 4500 had goitres. This over-all rate of approximately 10% rose markedly in certain groups and in certain places. Thus, at Takitount in the Department of Constantine, 189 children out of 200 (94.5%) were found to be goitrous; at Souma 65% and at Cap Aokas 61% of children were victims. Women were more intensely affected than men; in an area of high endemicity the figures were 71% for women and 23% for men. Cretinism appears to be rare in Algeria, and among the 40,000 people examined there was not a single case of deaf-mutism.

Vergoz and his colleagues make a strong plea for the introduction of iodized salt in Algeria. They do this from general economic and humanitarian considerations rather than because they think the goitre scourge in Algeria is exceptionally severe; in fact, goitre is much less intense there than in many other countries. They remind us that although goitre may not kill and although its lighter incidences may not seriously affect the behaviour of the subjects (mildly goitrous children are able to pursue their studies and adults are able to marry and have children) it is nevertheless a degenerative social malady from which greater evils may develop and involve unnecessary charges on the medical services of the state. The charge against public funds for goitre operations in Algeria has been
The red hatching indicates the areas where endemic goitre has been found.
estimated by Vergoz & Sicard. Hospitalization and surgical treatment of a single case costs 180,000 French francs. The hospital of Mustapha alone deals with 150 goitre operations annually, thereby incurring a total expense of 27 million francs. Similar costs apply in many other Algerian hospitals operating in the endemic zone. These facts should be faced and preventive measures applied.

The iodine contents of drinking-waters from a non-goitrous locality and from two widely separated goitrous localities in Algeria are compared by Vergoz, Boulard & Bernard. The figures have an obvious significance:

\[
\text{\(\mu g\) of iodine per \text{litre}}
\]

<table>
<thead>
<tr>
<th>Location</th>
<th>Iodine Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>Algiers (no goitre)</td>
<td>2.0</td>
</tr>
<tr>
<td>Souma (goitrous)</td>
<td>0.7</td>
</tr>
<tr>
<td>Cap Aokas (goitrous)</td>
<td>0.2</td>
</tr>
</tbody>
</table>

These authors also state that salt supplied for domestic consumption in Algeria, of whatever origin, has a very low iodine content.

**Morocco**

In former Spanish Morocco goitre is called “Hansla” by the local people, and endemic centres are to be found scattered here and there along the Rif mountain chain. Two of these have been studied in some detail—the kabila of Beni Jaled by Manuel Amaro and the kabila of Beni Ahamed by Alonso Romeo.

The kabila of Beni Jaled consists of 72 hamlets with a total of 14,200 inhabitants. The district lies in the mountains almost at the centre of the country and through it runs the main highroad connecting the towns of Melilla in the east and Tetuan in the west. Goitre occurs in only four of the 72 hamlets in the kabila—namely, Achedad, Ifartan, Takasbut and Taska. Out of a total of 300 persons in these four centres taken together, Manuel Amaro found 18 cases of simple goitre, 2 cretins, 2 deaf-mutes, and 1 case of Graves’ disease. In each village the affected persons were near relatives all deriving their supplies of drinking-water from the same springs. Large quantities of turnips are eaten by these people; indeed, turnips constitute a staple food. Manuel Amaro believes this to be a causal factor but thinks also that the district is poor in iodine owing to its altitude and the mountain barriers which shelter it from the sea. The prevailing wind is from the desert south.

Beni Ahamed, the second district in which a goitre survey has been made, adjoins Beni Jaled on the west. Maximum intensity in the zone occurs in the townships of Dar Gaba, Tafsa, Bazet and Kelala. Alonso Romeo made a careful clinical examination of 91 cases drawn from 19 townships, and among these he diagnosed hypothyroidism, hyperthyroidism and one case of cretinism.

The endemic area covering the centre of former Spanish Morocco extends southwards into the north of former French Morocco, where,
according to Alonso Romeo, the kabila of Beni Zerual is greatly affected. However, there do not appear to be any precise accounts of the nature and distribution of goitre in former French Morocco. During their investigation of endemic fluorosis in the phosphate-mining community at Khouribya, which lies inland about 60 miles south-east of Casablanca in the direction of the Atlas Mountains, Murray & Wilson found no evidence or record of goitre in this area. The mean iodine content of four samples of water from the supplies used by the Khouribya settlement was 10 µg per litre, a relatively high amount which would probably account for the absence of thyroid disease in this area of endemic fluorosis.

**Madeira and Canary Islands**

With regard to the islands lying off the north-west African mainland, goitre is said to be rare on Madeira but rather prevalent on Santa Cruz de la Palma, one of the most westerly islands of the Canary group.

Hernández Feliciano examined 274 cases (13 men and 261 women, the great majority of whom were in middle adult life) from 14 localities and found that the dominant clinical characteristic was one of hyperthyroidism. A map giving the distribution of the 274 cases shows that the disease is not localized but may be found all round the island at widely separated places:

<table>
<thead>
<tr>
<th>Location</th>
<th>Cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Santa Cruz</td>
<td>86</td>
</tr>
<tr>
<td>Breña Alta</td>
<td>8</td>
</tr>
<tr>
<td>Breña Baja</td>
<td>4</td>
</tr>
<tr>
<td>Mazo</td>
<td>32</td>
</tr>
<tr>
<td>Fuencaliente</td>
<td>1</td>
</tr>
<tr>
<td>El Paso</td>
<td>13</td>
</tr>
<tr>
<td>Los Llanos</td>
<td>54</td>
</tr>
<tr>
<td>Tazacorte</td>
<td>30</td>
</tr>
<tr>
<td>Tijarafe</td>
<td>2</td>
</tr>
<tr>
<td>Puntagorda</td>
<td>5</td>
</tr>
<tr>
<td>Garafia</td>
<td>8</td>
</tr>
<tr>
<td>Barlovento</td>
<td>2</td>
</tr>
<tr>
<td>Puntallana</td>
<td>7</td>
</tr>
<tr>
<td>San Andrés</td>
<td>22</td>
</tr>
</tbody>
</table>

Later, he extended his survey to 1104 schoolchildren among whom he found goitre rates of 46.3% in 575 girls and 35.5% in 529 boys.

La Palma is a mountainous island of underlying basaltic structure covered by a thick cap of porous volcanic rock and profusely covered with lava, tuff, and banks of sand. The iodine content of the drinking-water, derived chiefly from springs, is exceedingly low; values for samples drawn from nine different localities ranged from 0.11 µg to 0.87 µg per litre, with an average of 0.27 µg per litre. Hernández Feliciano stresses the need for prophylaxis by means of iodized salt.

His study is impressive refutation of the common belief that coastal areas and sea-girt islands are goitre-free.

**French West Africa**

Of all national goitre surveys none has been bolder in conception, vaster in area, more exacting for the surveyors, and in its results more satisfy-

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*At the time when the survey described under this heading was conducted, French West Africa was still a political entity.*
ing for its promoters and for the reviewer than that conducted by the medical officers of the Government Public Health Service in French West Africa under the impetus and direction of Dr Léon Pales.971-977

The former Federation of French West Africa embraced the following eight separate territories: Mauritania, French Sudan, Upper Volta, Niger, Senegal, French Guinea, Ivory Coast and Dahomey; it covered an area of more than 1,800,000 square miles (4,600,000 km²), nearly nine times that of continental France, and had a population of about 16,000,000. During the year 1948 the medical administration examined 3,162,039 people, of whom 153,591 were found to be goitrous, that is, 4.86%. At that time Pales concluded from these statistics that there were probably not less than 700,000 sufferers from goitre in all French West Africa.

A further investigation was made in 1950 to fill gaps left in the 1948 inquiry and to complete as far as possible the detailed map of distribution. The number of Africans examined has now risen to 4,449,040, of whom 371,205, or 8.3%, were found to be suffering from endemic goitre. If this new knowledge be accepted as the basis of a general estimate, it will be seen that rather more than 1,300,000 people are afflicted with goitre in this area and that Pales’ earlier figure of 700,000 was an underestimate.976

Excellent maps prepared by Pales & Tassin de Saint Péreuse on a scale of 1:2,000,000 and printed in five colour gradations from yellow to dark-brown show the distribution and varying intensity of the endemic in French West Africa and also the names of the tribal races occupying the affected locations.972, 975, 976 Looking across the map from west to east and south-east, the following areas stand out as the most goitrous:

Senegal

Rates of 14% to 40% are common in the cantons in low-lying east Casamance on the banks of the Songrougrou and Casamance rivers just south of the Gambia. High rates are also found around Dialakoto on the upper waters of the Gambia river.

Guinea

There are centres of high prevalence (from 12% to 30%) throughout the Fouta Djallon mountain region, which covers practically the whole of the central part of the territory. Farther east, rates of 20%, 40% and 50% occur in some of the cantons around the town of Siguiri. To the south of Guinea, where it borders on Liberia and the Ivory Coast, the endemic is severe around Macenta, Beyla and N’Zérékoré.

French Sudan and Upper Volta

The goitre area at Siguiri continues eastwards without interruption through the southern part of French Sudan and into the territory of Upper Volta. Among strongly affected areas are those adjoining the towns of Bougouni, Ségou and Koutiala in the Sudan, and an extensive region
encircling the town of Dedougou north of Bobo Dioulasso in Upper Volta. The most northerly focus in this general area, and indeed one of the most severe in all French West Africa, lies near Bandiagara about 200 miles due south of Timbuktu. Here, eight communities register rates of 40% to 73%.

Ivory Coast

The principal goitre centre in this territory lies in the mountainous region of Man. It forms part of the Beyla and N’Zérékoré belt in southern Guinea and shows rates of anything from 10% to more than 40%. Another prominent focus lies to the east-centre of the country immediately north of Katiola 200 miles from the sea, where rates of 31% and 42% have been recorded in the cantons of Fondébougou and Kembigué, respectively.

Dahomey

This narrow strip of territory in the south-east is not so seriously affected as some of the other territories that made up the Federation. Nevertheless, there are centres of goitre in the north around Natitiagou and Kandi, and also on the right bank of the Niger opposite the Canton of Gaya.

Viewing former French West Africa as a whole, there would appear to be more goitre in mountainous regions than on the plains. But prevalence has not necessarily any connexion with altitude; thoroughly investigated villages, in which a very high proportion of the inhabitants were examined, have shown rates of 30%, 40%, 50% or even more, whether situated in mountainous country or on the plains, in savanna or in the forest. Two facts, however, may be regarded as axiomatic: goitre is extremely rare on the Atlantic sea-coast and is likewise extremely rare in the regions of the Sahara. Indeed, in this part of Africa goitre is practically non-existent north of the 14th parallel, a line which constitutes an almost rigid east-west barrier between the goitrous and non-goitrous zones. The territories of both Mauritania and Niger lie north of this parallel; almost no goitre is found in either.

An arresting explanation is advanced by Pales for this remarkable phenomenon of disease-geography. For the most part, the highly endemic zones are sited upon soil foundations of granito-gneiss—a fact confirmed by Wilson in her later survey of Sierra Leone. Pales, however, does not pay so much regard to this immutable geological consideration as to the fact that in the area covered by his survey, the greater part of which lies to the south of the 14th parallel, the goitrous terrain is precisely the area in which the native peoples are dependent for their supplies of cooking and seasoning salt on “pot-ash” derived from the incineration of local plant foods, and are by reason of economic and transportation difficulties precluded from access to natural sodium chloride derived from sea-water by solar evaporation at coastal centres or from the rich salt-producing areas in the south Sahara.

There is little need, Pales says, to suppose a one-time sea in the Sahara to explain the possible presence in the Sahara salts of sufficient iodine to
confer goitre immunity on the peoples inhabiting that particular zone or any zone to which Sahara-produced mineral salt becomes available in the natural course of trade. The fact is, however, that the Sahara salt trade-routes have never penetrated much below the 14th parallel. Peoples long established south of that line have for the most part been dependent on vegetable salts that are rich in potassium but may contain little iodine, or indeed, as Pales postulates, may possess a subtle goitrogenic agent as yet unidentified. Inquiries to settle these unanswered questions are proceeding.

In the territories of former French West Africa goitre is about twice as prevalent in women as in men; it is more frequent in adults than in children. According to Denuix, whose investigations apply principally to the Upper Volta, the age of greatest frequency extends from 10 to 30 years, with a maximum towards the 15th year, that is to say, about the period of puberty. The largest goitres are seen in old women. It cannot be stated with certainty whether diffuse parenchymatous goitres or nodular goitres are the more prevalent, but it is probable that the diffuse type is the commoner. Cases of hyperthyroidism are exceptional, and in the statistics cancer of the thyroid is very rarely noted.

Goitrogenic cruciferous plants, more particularly the genus Brassica (cabbages, turnips, kale, etc.), do not figure in the native dietary. Indeed, the soils of this region of Africa are of a type far from being favoured by the Cruciferae. Consequently, these are few in number and variety, and, oddly enough, the ones that do occur are found mostly in zones free from goitre.

Prophylactic trials with iodized salt are in active progress and have already given highly promising results, especially at Macenta in Guinea just north of the Liberian border. Pales hopes that these first demonstrations of the efficacy of iodine as a goitre preventive are but the prelude to the systematic iodization and distribution of commercial marine salt extracted in the salt works of the Sine Saloum at Koalack, in Senegal, where the present annual production amounts to 50,000 tons and could be increased without any difficulty. Various grades of salt marketed in jute bags from the Koalack factory, and fortified with iodide and iodate at two different levels, have been subjected to storage and transportation tests. Coarse salt fortified with iodate is the most satisfactory, inasmuch as iodate does not migrate to the sides and bottom of the bag. Even so, the problem of iodine loss has not yet been finally solved; more than half the iodate in coarse salt disappears within 3 months of storage under inland climatic conditions.

Besides spreading over extensive tracts of country in former French West Africa, the goitre belt in this part of Africa also extends into the territories of Gambia, Sierra Leone, Ghana (formerly the Gold Coast) and Nigeria; it continues southwards through Cameroun into the hilly districts of northern Angola. A map showing the distribution of endemic goitre in
relation to the geological occurrence of pre-Cambrian rocks throughout the whole of West Africa is given by Wilson et al. 988

**Gambia**

Writers on goitre in this part of the world are wont to say that the explorer Mungo Park 989 saw goitrous people in Gambia when making his way to the upper waters of the Niger in 1795-96. He mentions having seen cases in the Bambuk country and in the neighbourhood of Segu; but these places lie hundreds of miles beyond Gambia to the east, and it is not certain that Park saw goitre actually in Gambia itself.

That the disease does occur there, however, has been recorded by Todd 989 and more recently by M. P. Hutchinson (personal communication to D. C. Wilson, 988 1952). The affected area lies in the upper river district to the east where the pre-Cambrian granite formations begin, and is obviously linked up with the Senegal endemic in the same region. It would not be surprising, either, if goitre were found in the centre of the country in the neighbourhood of Georgetown because, in Senegal, both north and south of the Gambia river at this point, goitre is known to occur (see page 119).

**Sierra Leone**

“Ballansama is a man of the middle size, of a jolly appearance, both in person and expression, though a little disfigured by a large wen on his throat, which appears a disease very common to the Koorankos.” That is how Laing 986 described the King of Northern Koranko whom he met in 1822 when travelling through the interior of Sierra Leone to explore the sources of the Niger. The Koranko country is goitrous today. In fact, Sierra Leone provides an excellent example of how, in spite of energetic studies at widely separated intervals of time and strong recommendations for iodine prophylaxis on more than one occasion, only desultory efforts to remedy the situation have as yet been made and goitre still persists.

During December 1923 and the early part of 1924, Blacklock 981, 982 and his wife made a strenuous three-month tour into the hilly regions of the east and north through the tribal country of the Kono and Koranko, where they found goitrous people in considerable numbers. Their findings were fully discussed at a meeting of the Royal Society of Tropical Medicine in 1925, when Blacklock concluded his address with these words: “I am particularly anxious to ascertain what is the experience of members of this Society in regard to the administration of iodine to populations, because if the risks are indeed negligible, it is our duty to take steps to deal with the problem of goitre in our tropical possessions as soon as possible.”

Almost exactly thirty years later, Wilson 988 traversed more or less the same route, found high percentages of goitre where Blacklock found them,
showed that the affected areas coincide with the distribution of granitic rocks of pre-Cambrian geological age, and correlated the prevalence of the malady with low iodine content of drinking-water. In her paper to the same Society, she makes the following comments: “There is thus a belt of endemic goitre from Senegal to Angola which deserves the attention of administrators and clinicians in order that appropriate remedial measures may be instituted. The time [in Sierra Leone] is very favourable for the introduction of iodized salt which is the easiest method of dealing with goitre prophylaxis.”

Both Blacklock’s observations and those by Wilson a generation later show that goitre is absent in the low-lying western parts of Sierra Leone towards the coast; these goitre-free areas are situated on comparatively modern geological formations overlying earlier rocks. In the upland eastern section of the country the endemic affects the Mende, Kissi and Kono peoples dwelling in the Kenema, Kailahun and Kono districts of the South-Eastern Province. Among Kono men and women a rate of 56% was noted by Wilson; the thyroid gland was frequently much enlarged, multinodular and cystic, and obvious goitre was sometimes present in young children, but no case of congenital goitre was seen. Farther north, the disease occurs among the Koranko living at the base of the Loma Mountains and in the Koinadugu district of the Northern Province where a rate of 71% has been recorded by McIntyre in Bendugu village.

On a route from the south to the north of the goitre areas a traveller would pass through the following places of high incidence—Jiama, Paya, Kaiyima and Yaiya in the Kono country, and Saywaia, Kruto, Bandakarafaia, Kimadugu, Bendugu, Kaballa and Dankwalli in the Koranko country. These villages all lie at the head-waters of the Sewa, Bagwe and Rokel rivers on the watershed between Sierra Leone and the sources of the Niger in Guinea.

As already mentioned, the areas of endemic goitre in Sierra Leone are associated with pre-Cambrian granite rocks which have become altered by intensive weathering under tropical conditions. It would appear that the chief factor influencing goitre distribution is that these rocks have gradually been deprived of iodine by leaching and that, in consequence, the waters issuing therefrom have an exceedingly low iodine content. Wilson and her colleagues give the following figures:

<table>
<thead>
<tr>
<th>Area</th>
<th>Goitre rate (%)</th>
<th>Iodine content of water (µg per litre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highlands (to the east):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Koinadugu (Koranko)</td>
<td>42.9-71.0</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>Kono</td>
<td>55.9</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>Kenema and Kailahun</td>
<td>19.0-24.7</td>
<td>&lt;1.0</td>
</tr>
<tr>
<td>Lowlands (to the west):</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kambia—Port Loko area</td>
<td>no goitre</td>
<td>1.0-2.8</td>
</tr>
<tr>
<td>Moyamba—Bo area</td>
<td>no goitre</td>
<td>4.3</td>
</tr>
</tbody>
</table>
Goitre was found to be endemic where the waters contained less than 1.0 μg of iodine per litre, but was not recorded where the iodine content was 2.4 μg per litre or above. Sea-fish, the other important source of dietary iodine, is obtainable by most people near the coast but is rarely eaten in the more distant inland areas where goitre occurs. Another factor which, according to Wilson, may contribute to the causation of goitre in Sierra Leone concerns the intake of vitamin A from red-palm oil. It will be recalled that Haubold found a high prevalence of goitre in mountain villages in Bavaria associated with a low intake of vitamin A and carotene. In Sierra Leone the intake of fats is generally speaking adequate and that of vitamin A from red-palm oil is high. But the availability of red-palm oil depends on oil-palm density, which in the goitre areas of Kono and the adjacent Koinadugu country is not nearly so high as elsewhere, and supplies suffice only for a short season. It is possible that this seasonal scarcity may help to precipitate goitre in places where the iodine content of the diet is already precariously balanced on the borderline between sufficiency and insufficiency.

Ghana

In the extreme north of the Northern Territories of Ghana goitre has been noted by F. C. Rodger (personal communication to D. C. Wilson, 1953) on the banks of the Red Volta and also for 50 miles along the Sissili river, a northern tributary of the Volta. He describes the goitres as "colloid-looking" and, in one place, as being associated with fluorosis. In this same general area goitre has also been observed by B. B. Waddy (personal communication to D. C. Wilson, 1954) near the junction of the Red and White Volta rivers and in the Navrongo and Bawku districts close to the boundary between Ghana and the Republic of the Upper Volta (formerly the Upper Volta Territory of French West Africa).

Nigeria and British Cameroons

When journeying through Nigeria in the early years of this century, Tonkin came across goitre in Gitata, a small pagan village perched high on a rocky ridge, almost exactly in the centre of the country immediately north of Keffi on the trade route between Loko on the river Benue and Zaria some 200 miles northwards. Tonkin estimated that 20% of the village inhabitants were affected, some with very large goitres. He saw no sign of the disease in the valleys on either side of Gitata.

Several later and more or less casual observations have been made from time to time—notably by Denfield who has vividly portrayed the goitres seen in the Bauchi Plateau in a series of remarkable photographs—but it was not until 1951-53 that Wilson and her colleagues correlated the various scattered pieces of information, added to them, and presented a picture of the Nigerian endemic as a whole.
Broadly speaking, the geological layout of Nigeria consists of three upland areas of pre-Cambrian granite—one in the north, one in the south-west, and one in the south-east—separated from each other by belts of marine sediment lying roughly in the form of a letter Y across and down the middle of the country. These belts follow the great valleys of the rivers Niger and Benue, the one flowing from the north-west and the other from the north-east along the converging arms of the Y to meet at Lokoja and thence sweep southwards to the sea as one.

The goitrous areas invariably lie on the granites of the pre-Cambrian complex, or in districts dependent on waters derived from these rocks. Goitre is absent on the marine sediments of the Niger-Benue river basins. The central plateau in the cup of the Y, an area studied by Wilson more intensively than any other, is of special interest inasmuch as basaltic and lava flows of Tertiary and Recent Age cover part of the granite. Here, families living or farming on the basalt are free from signs of goitre; they obtain much larger yields of crops. For example, the Vom section of the Berom tribe live on granite but farm on basalt and are mostly non-goitrous; but another section of the Beroms, not far away at Forum, live and farm on granite and have many goitrous women among them. Similarly, on the escarpment between Pankshin and Shendam towards the south of Plateau Province, and in the adjoining parts of Bauchi Province, goitre is common among tribes using waters that drain off the granite formations of the Naragota, Shere, Jarowa and Jere hills.

Wilson lists the goitre districts of Nigeria as follows:

**Northern Region**
- North-west and south of Sokoto
- North of Niger
- East of Katsina
- West of Kano
- South of Bornu
- North-east of Ilorin
- East of Niger
- South and east of Zaria
- West and south-east of Bauchi
- North and east of Benue
- Many parts of Plateau Province
- East and west of Kabba

**Western Region**
- North of Oyo
- North and west of Ondo

**Eastern Region and British Cameroons**
- North of Ogoja
- Western part of Mamfe Division
- Bamenda District and south of Yola

All these areas of endemic goitre lie on granites of the pre-Cambrian basement complex, or are associated with waters which drain off these rocks. The only exception, as explained above, is on the central plateau, where an obvious difference in prevalence and degree of thyroid enlargement (much less, if any at all) was found amongst aboriginal peoples living in granite districts overlain by basaltic lava flows of more recent origin.

The prevalence in relation to the iodine content of the water-supplies in these districts of differing geology is brought out in Table XI (Wilson 987).
TABLE XI. RELATION BETWEEN PREVALENCE OF GOITRE AND IODINE CONTENT OF WATER-SUPPLY IN SOME PLACES IN NIGERIA

<table>
<thead>
<tr>
<th>Place</th>
<th>Source of water</th>
<th>Number of subjects examined</th>
<th>Percentage with goitre</th>
<th>Iodine content of water (µg per litre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zagun</td>
<td>Older granite of pre-Cambrian basement complex</td>
<td>162</td>
<td>46</td>
<td>0.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.7</td>
</tr>
<tr>
<td>Miano</td>
<td>Basaltic lava flows of Tertiary and Recent Age</td>
<td>150</td>
<td>Nil</td>
<td>5.0</td>
</tr>
<tr>
<td>Vom</td>
<td>Pre-Cambrian granite, but people farming mainly on basalt</td>
<td>250</td>
<td>3</td>
<td>0.6</td>
</tr>
<tr>
<td>Abakaliki</td>
<td>From deep water shaft, Marine sediments, Niger river basin</td>
<td>301</td>
<td>Nil</td>
<td>92 *</td>
</tr>
</tbody>
</table>

* On lead-zinc mine; probably exceptional

The exact incidence of goitre throughout Nigeria is unknown. Among Rukabi families in Zagun village, Wilson found an average rate of 46%, the distribution being 32% in adult men, 72% in adult women, 23% in boys and 25% in girls under 16 years of age. Hyperthyroidism is rare, but cretinism and deaf-mutism are frequently seen. In Nigeria livestock are moved about over wide areas, and the only recorded occurrence of goitre among animals concerns a herd of pigs belonging to a bacon factory situated in a district where human goitre is prevalent; the condition cleared up following the administration of an iodine supplement.

There is no evidence that goitrogenic factors other than iodine-deficient waters are operative in Nigeria. The endemic is not confined to regions where vegetable ashes are used as salt, as is the case in former French West Africa (see Pales 971, 973, 974). Local sources of salt are insufficient for the country's needs; accordingly, imported salt is sold in Nigerian markets. The question of making iodized salt the only type imported into Nigeria is being considered by the Federal Medical Department.993 Already, regulations prohibiting the use of non-iodized salt have been made by Tiv, Nasarawa, Zaria, Idoma, Igala, Donga and Takum Native Authorities in the Northern Region. Iodized salt means salt to which has been added potassium iodide in a proportion of not less than one part in fifty thousand.

Cameroun and French Equatorial Africa a

Two highly interesting zones of endemic goitre have been the subject of study by doctors of the French Colonial Service—one in the Lom-Kadei

a At the time when the studies described here were conducted, Cameroun had not become an independent republic and French Equatorial Africa still existed as a political entity.