TRISTAN DA CUNHA: GENERAL MEDICAL INVESTIGATIONS¹

BY

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The unexpected presence in Britain of the whole Tristan da Cunha community (Samuels, 1963) gave a unique opportunity to study this inbred group. The population of 259 is divided into 70 family units, but there are only seven surnames. We had been led to believe that they enjoyed an unusually high standard of health, but in fact the picture was more that seen in an underdeveloped country where, of necessity, continuous medical care and public health were difficult to achieve.

The Medical Research Council appointed a working party to study the Islanders' health. The programme had two main themes: assessment of the incidence of disease, together with the prescription of therapy where indicated; and, where opportunities were available, research.

When the investigation was started the Islanders were housed temporarily in wooden huts at Pendell Camp in Surrey; subsequently they were given accommodation in cottages at Calshot, Hants. They had arrived during the severe winter of 1961-2 and nearly all were suffering from infection of the upper respiratory tract. There was an epidemic of acute bronchitis followed by an epidemic of an influenza-like illness with high morbidity. There were four deaths, at least three of which resulted from an apparently overwhelming respiratory infection. The general impression was that the Tristanians were much more prostrated as a result of this epidemic than was the indigenous population.

Methods

A full clinical examination was carried out and recorded on a modified Hammersmith Hospital form.

All adults and children in the camp were examined, the total being 198 adults (97 females and 101 males) and 61 children—that is, those under 13 years old (36 girls and 25 boys).

Urine was tested routinely for the presence of protein and reducing substances, and for phenylketonuria in the children. All provided a fresh specimen of stool for examination for cysts, ova, and parasites.

A specimen of blood was taken for routine haematological examination, and small portions were used for haemoglobin and plasma-protein studies, bacteriological and virological investigations, and blood grouping. The extensive serological survey has included tests for venereal disease, autoimmune bodies, common cold virus, and poliomyelitis antibodies and toxoplasmosis.* Special importance was attached to the work of the Blood Group Reference Laboratory because of the unique historical background of the Islanders.*

All the Islanders' chests were mass x-rayed and a B.C.G. survey was carried out (Sakula, 1963).

General Appearance

The Islanders appeared to be young for their age, robust, thin, and of rather less than average weight. About half of them were dark-skinned, although the degree was

variable. The faces were Caucasian, and they bore a striking resemblance to one another. The children were shorter than their British counterparts and also lacking in subcutaneous fat, although the musculature at all ages was normal. About one-third were obviously suffering from dental caries (Holloway *et al.*, 1962) and one-fifth had noticeable fetor oris and gingivitis.* There was no clinical evidence of obvious anaemia or vitamin deficiency.

Mental State

The Islanders were, on the whole, a cheerful, pleasant, and unusually co-operative group and readily answered questions. They spoke English with a distinctive and unusual dialect.* Their memory for past events was poor, and they were obviously used to a much slower tempo of life than obtains in Great Britain. They were noticeably free, with very few exceptions, of anxiety and worries* and, superficially at least, appeared to accept their lot with remarkable phlegm. They appeared to be of reasonable intelligence, taking into account the obvious differences of schooling and environment between them and their British contemporaries. At this stage we carried out no formal intelligence tests. Among the adults 21 were mentally dull (13 males and 8 females) in association with abnormalities of the pinna, palate, and deafness (see Table II). In addition, four males and two females were particularly retarded, though without the associated abnormalities.

Past Illnesses

It was remarkably difficult to get a history of any illness, unless dramatic, that occurred more than two years previously. The Islanders remembered little of the past, and that inaccurately. Very little reliance can be placed on their statements concerning anything that had occurred very long before. However, an epidemic of varicella that took place about 10 years previously was remembered to have infected 89 (45%) of the adult island population and 26 (42.6%) of the children. Similarly, an epidemic of measles three years before had infected 125 (63%) of the adults and 35 (57.4%) of the children. An outbreak of mild jaundice, probably due to infective hepatitis, had been in progress on the island since about May, 1961, and 131 (66%) of the adults and 11 (18%) of the children had contracted it. The other illnesses usually remembered were fractures, and these predominantly involved males, the commonest injuries being fractured ribs, elbow, and ankle, in order of frequency.

There was one case of amputation of the right arm, one man had had an accidental gunshot wound in the left shoulder, and another had ruptured his biceps while

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*An asterisk in the text denotes a specialized investigation.

chopping wood. One woman had had a gastrectomy and three had had an appendicectomy. One man had had snow-blindness when working in the Falkland Islands Dependencies; one man had been treated for pulmonary tuberculosis, and another had had Bell's palsy. There was a past history of epilepsy in two Islanders; in one the attacks followed a blow on the head from a cricket ball, and the other had a single attack after an episode of otitis media.

Personal Habits

None of the women smoked, though 63 of the men did. Of the men, 18 (17.8%) smoked a pipe, the average consumption being 1.6 oz. (45 g.) a week, with a range of $\frac{1}{2}$ to 4 oz. (14 to 113 g.). Forty-five (44.6%) smoked cigarettes, the average consumption being 8.1 cigarettes a day, the range 1 to 50 a day. The average age of the cigarette smokers (40.3 years, with a range of 18 to 72 years) was somewhat younger than that of the pipe smokers (51.3 years, with a range of 29 to 71).

Alcohol was consumed by both sexes, though mainly by the men. Seventy-five (74.3%) of the men and 15 (15.5%) of the women drank alcohol on occasion in some form. It was difficult to get an estimate of the quantity taken.

Respiratory Illness

On reaching England the Islanders proved very susceptible to infections of the upper respiratory tract. Even on the island, when a ship called, an epidemic of colds would follow. The majority of the adults and children had a common cold* at the time of our examination.

On the island, and in this country, the commonest respiratory complaint other than the common cold was asthma (the "hasmere," or "tissick"). This consisted of varying degrees of tightness of the chest, usually occurring in association with infections of the upper respiratory tract. Sixty-three remembered it affecting other members of their families. The adults commonly recalled it as starting in early or middle childhood, and then it affected them intermittently for the rest of their lives. Most were well between episodes, but during a typical attack apparently brought on by a common cold they became severely dyspnoeic, wheezy, distressed, and sometimes cyanotic as well. Of the adults, 96 (48.5%) were affected at some time—slightly more females (51 or 52.6%) than males (45 or 44.6%). Just under half of those affected complained of breathlessness during their asthmatic attacks; the sexes were affected equally. On examination 57 (28.8%) adults were wheezing (64.5% of the asthmatic males and 54.9% of the asthmatic females). Wheezing was noted in 7 (11.7%) children, though in only two was there a history of asthma.

We were unable to elicit a significant history of allergy among the Islanders, but one gave a history of angio-neurotic oedema, one had developed a sensitivity rash to a familiar detergent, and another had a true atopic eczema. There was only one person who admitted to hay-fever and he had had it only during early manhood. The only factor precipitating asthmatic attacks that we were able to elicit was the common cold; however, a more thorough investigation of a possible allergic basis will be the subject of a later report.

There was evidence of chronic bronchitis, in that 117 (59.1%) of the adults admitted to having a chronic cough, usually made worse by colds. When we examined them most of the Islanders had coughs; 47 (40.2%) of those with a cough had scanty mucoid sputum and 36 (30.8%)

had mucopurulent sputum. We found a barrel chest in 24 adults, 20 (83.3%) of whom were male. This deformity was found in one asthmatic child. We found Harrison's sulci in three males, and an asymmetrical chest (in the absence of other abnormalities) in two males and one female. One male had a pigeon-chest deformity. A funnel chest was found in 21 adults (85.7% of them male), but in no child.

There were two patients with active tuberculosis.*

Cardiovascular Abnormalities

One woman, now aged 66, had a past history of congestive cardiac failure. Her blood-pressure was 175/100 mm. Hg. The cardiac failure occurred eight years previously and one year ago she had had an episode of transient chest pain which had not been diagnosed. One man, aged 66, had angina of effort, but was not hypertensive. One woman remembered that her father died of heart disease, and nine (five of whom were of one family) remembered a close relative dying of a "stroke."

We found apical systolic murmurs in several adults and one child, but many of these altered with posture or respiration, or both. In only two was there a significant heart murmur: one was a woman of 21 who had the signs of mitral stenosis, but who was symptomless; the other was a 13-year-old girl who, despite a mild dyspnoea, was able to lead a normal life—she was found to have a ventricular septal defect and a moderate left-to-right shunt (Dr. Wallace Brigden).

The peripheral pulses were palpable and normal in almost all, including the elderly. There was no example of peripheral ischaemia. Hypertension was diagnosed when the blood-pressure rose above 140/95 mm. Hg, though only one reading was taken, always at the end of the examination. By this criterion 22 (11.1%) of the adults had an elevated blood-pressure; 3 (3%) of the males and 19 (19.6%) of the females. Only two of these (both females) had clinical evidence of left ventricular hypertrophy. Blood-pressure levels, for sex and age, showed no significant difference from the distribution seen in comparable groups in this country. We found no evidence of heart failure. Two of the females and one male had a mild hypertensive retinopathy, consisting of nipping of the arteriovenous crossings with slight fullness of the veins. In many of the young adults elevation of the blood-pressure was understandably associated with anxiety at the time of the examination.

TABLE I.—Mean Blood-pressure Readings by Decades (mm. Hg)

Age	No.	Males Mean Blood-pressure		Females Mean Blood-pressure		
		Systolic	Diastolic	No.	Systolic	Diastolic
10-19	16	121.3	71.6	14	120.7	72.1
20-19	19	137.9	81.3	27	127.0	74.8
30-39	23	129.6	80.7	18	135.0	82.8
40-49	14	127.1	76.1	16	139.1	84.4
50-59	16	135.0	80.0	9	153.3	93.3
60-69	11	136.4	79.1	8	163.1	90.6
70-79	2	155.0	90.0	2	165.1	95.0
80+	0	—	—	2	—	—

Abdominal Abnormalities

The main complaint was indigestion. We found a history of this in 45 adults (22.7% of the adult population), and this involved 28 (27.7%) males and 17 (17.5%) females. The history was difficult to elicit, but the symptoms, although often atypical, appeared genuine; the discomfort usually came on one-half to one hour after

meals and rarely woke the sufferer at night. It affected all age-groups, and in many it had been present for years.

Fried foods were not often incriminated; food was not often prepared this way. In only five (two males and three females) was there epigastric tenderness, and the indigestion was disabling in only one woman who was depressed and a somewhat pathetic person. One man had a succussion splash, but no history of vomiting. One man had had a partial gastrectomy performed in Cape Town several years before, with relief of his symptoms. It was noticeable that three families particularly were susceptible to this ailment.

We found little else wrong in the course of our examination of the abdomen. Two women had ventral herniae and one child had an umbilical hernia which had been repaired surgically. Many complained of diarrhoea, as they had done on Tristan, and some of colicky pain associated with it. The stool examination revealed a high degree of intestinal parasitic infection.* Some of these parasites had not been reported previously among the Islanders (Thacker, 1963).

Ten males had enlargement of the prostate, but none with severe symptoms. The mean age of this group was about 55, the range being 31 to 72 years.

One 20-year-old man had had a left nephrectomy performed eight years previously for a renal stone. He has had no recurrence in the other kidney.

Orthopaedic Abnormalities

Apart from a history of trauma, the only significant symptom was of backache, almost invariably lumbosacral in site, and occurring after unaccustomed weight-lifting or a long day's work in the fields. It affected 31 adults, of whom 27 (87.1%) were males and 4 (12.9%) females. There were physical signs compatible with a protruded intervertebral disk in two young men, but there were no signs of neurological involvement in any. We could find no evidence of past rickets in adults or children. One woman (who was overweight) had genu valgum, and we found hyperextensibility of the joints in one male and four females. This was not accompanied by any other obvious defect.

Mild thoracic scoliosis was visible in two males and four females, and lumbar scoliosis in a further one male and two females. Seven females and two males—all middle-aged—had clinical evidence of osteoarthritis of the knees, and one male had a painful shoulder, movement of which was associated with crepitus in the region of the joint.

Ophthalmological Abnormalities

We found arcus senilis in only two people, both males aged 78 and 62, but cataracts of the senile type were observed in five females and two males. One female had old glaucoma predominantly affecting one eye; another female had a severe degree of myopia; and three males and one female had pterygia. One male had a dense opacity of the cornea and lens of the left eye secondary to trauma.

The striking abnormality of the eye, however, was the presence of retinal changes identical with retinitis pigmentosa.* This was very advanced in one young female. She had night blindness (as did eight males and three other females) and also a severe visual field defect. Her visual fields were restricted to central vision only. A less advanced form was found in three others. In these the

visual fields were not restricted to confrontation and they were unaware of any abnormality apart from their complaint of night blindness. They had not noticed their symptom till adolescence. In none of them did we find associated cataracts. In the others (apart from the most severely affected girl) the retinal changes were less evident. The incidence of retinitis pigmentosa is of grave significance if the Islanders continue as an isolated inbred community. The genetic implication is a high incidence of blindness in future generations (Sorsby, 1963). There were 12 other Islanders in whom we saw choroidoretinitis.* The possible role of toxoplasmosis in the aetiology of this condition is being investigated.

Other Congenital Abnormalities

The most striking association of abnormalities was that of nerve-type deafness, a high arched (Gothic) palate, variations of pinna shape, and mental dullness, and these together may constitute a syndrome. The occurrence in any one person of these abnormalities may be mere coincidence due to three or more genes situated close together on the same chromosome,* but it is conceivable that one gene could be responsible, the variations being due to incomplete penetrance. The incidence of these findings is shown in Table II. No data are available for comparison with the general population.

TABLE II.—Coincidence of Certain Congenital Abnormalities in the Adult Tristan da Cunha Islanders (See Text)

	Abnormal Pinna. High Arched Palate. Deafness	Abnormal Pinna. High Arched Palate. Dullness	Abnormal Pinna. High Arched Palate. Deafness. Mental Dullness	Abnormal Pinna. Mental Dullness	Abnormal Pinna. High Arched Palate	High Arched Palate. Mental Dullness	Total
Males (101) ..	1	2	1	6	3	4	17
Females (97) ..	1	2	1	3	10	2	19
Total ..	2	4	2	9	13	6	36

Nineteen females (19.6% of the female adult population) and 17 males (16.8% of the male adult population) were affected by this presumptive syndrome in its various forms. Most of those affected had one out of three surnames. The deafness was not profound, nor was the mental dullness, except in one girl who was severely affected by both conditions. All were capable of earning a modest living in a simple menial job, and their disabilities were no bar to marriage.

A high arched palate was seen as an isolated finding in a further 31 Islanders (21 males and 10 females), again most commonly in the same three families. Abnormalities of the pinna fell into three types and occurred also as an isolated finding in 37 people (13 males and 24 females). Once more, this was commonest in those with three particular surnames. Pinna variations were noted in one boy and one girl as an isolated finding.

Incurving of the little fingers were seen in 37 Islanders (9 males and 28 females). Accessory nipples were observed in 18 (11 males and 7 females). Short terminal phalanges were seen in 3 (1 male and 2 females). An abnormally wide separation of the eyes (hypertelorism) was seen in 3. One was a woman aged 23, who had male distribution of body hair but who was otherwise normal. One was a male aged 43 with an external strabismus. The third was a child (see below). One 19-year-old pubescent male had gynecomastia and a pigeon-chest. Another (a 15-year-old girl)

had pronounced micrognathia, present since birth. A 36-year-old woman had had an extra digit amputated from the left foot, and this was the only example of polydactyly seen. She had no other obvious abnormalities. A boy aged 15 had a funnel-shape deformity of his chest and penile hypospadias. His testes were in the scrotum. Another boy with hypospadias has been brought up as a girl. One child, aged 3½ years, had hydrocephalus associated with hypertelorism, mental retardation, and fits. Another had atonic cerebral palsy from a probable birth injury, also associated with fits. This child, aged 3 years, was blind and appeared to be ineducable.

Gynaecological Disorders

It was notable how rarely we obtained histories of menstrual difficulties. Only 16 (16.5%) of the women of all age-groups admitted to any abnormality at all. The commonest complaint was of heavy loss on the first day (in 8, since childbirth in 1), menorrhagia (1), irregularity (6), and a slight yellow vaginal discharge associated with scanty periods in a woman aged 21. The menopause apparently caused little trouble, and menopausal symptoms were admitted to by only one woman who was a rather neurotic and anxious person. Twenty women could remember when their menopause had occurred, and the average age of onset was 45.9 years, with a range from 36 to 50 years. Although miscarriages and stillbirths undoubtedly occurred on the island, we were nevertheless quite unable to form any sort of estimate of the frequency of their occurrence, as few of the women cared to admit to any such calamity having taken place. Nine women complained of stress incontinence, their average age being 52.1 years (range 24 to 85 years), and they had had, on average, 4.4 children (range 0–10). One woman had had an ovarian cyst removed, and another had had a dilatation and curettage performed for menorrhagia when aged 29.

Examination of Children

A routine paediatric history was taken and a normal out-patient examination was done for each child; more detailed investigations were undertaken where necessary. A history of the delivery was obtained for all but four children. The only four abnormal deliveries recorded were one forceps delivery, one rapid labour, and two long labours, the babies being normal in each case. The delivery of one child with cerebral palsy was described as normal, but the mother was ill during pregnancy, possibly from toxæmia; this was the only child with a history of post-natal feeding difficulties. One other child, with arrested hydrocephalus, was said to have had "soft" areas on his head at birth; this boy was severely retarded, both mentally and physically.

Routine weighing at birth had only recently been instituted; hence records were available in only 44 cases. The mean birth weight of these 44 cases was 7.60 lb. (3,450 g.), compared with 7.46 lb. (3,390 g.) in McKeown and Gibson's (1951) series in Birmingham. Three, possibly four, infants were premature, and 8 (18.1%) weighed 5½ lb. (2,500 g.) or less at birth, a high figure compared with most series. Breast-feeding was usually successful; of 57 births, 35 infants were breast-fed for two months or longer, the mean duration being 7.2 months. Mixed feeding was introduced at the usual time, the mean age being 6.3 months. Developmental histories were difficult to obtain and were vague, probably because the age of achievement of the various "milestones" was not subject to the obsessional interest usual in Britain. For the same reason,

presumably, it proved impossible to obtain a history of toilet-training.

Of the infections, which are described elsewhere in this paper, it is of interest that three infants caught measles from their mothers "at birth," "a few days after birth," and "at the age of 3 months," demonstrating the lack of protection in the young child in the absence of antibodies derived from the mother.

The heights of all but seven children were measured. Only five girls and three boys had heights above the 50th percentile. Complete anthropometrical data were obtained by Dr. J. M. Tanner and Mr. R. Whitehouse.*

Of the other physical findings at the time of the examination, the most striking was the almost universal coryza, acquired since leaving the island; a history of recent ear-ache was common, and a quarter of the children had some infection of the tympanic membranes, although a bulging drum was seen in only one child.

No attempt was made to estimate the intelligence of the infants and children.* They seemed bright and alert in spite of the blocked and streaming noses. The two children with cerebral palsy and arrested hydrocephalus respectively were severely retarded, and certainly ineducable.

Puberty

The average age at which the first menstruation was seen was 14 years (range 10 to 20 years), the menarche having been remembered by 62 women. The age at which puberty was achieved by the males (as judged by the onset of voice-breaking, pre-pubertal growth spurt, and development of male body hair) was apparently much later. It was not easy to determine, and information on this point was obtained from only 11 people; the average age at onset was 18.9 years (range 14 to 25 years).

Urine Tests

The urine was examined for glycosuria, proteinuria, and phenylketonuria with test papers. In the infants they were pressed against the napkin until wet. With these methods, neither glycosuria nor phenylketonuria was found, though slight proteinuria was discovered in 15 adults (8 males and 7 females) and in 6 children. On repetition of the test in 10 of the affected adults, the result was normal in 8. A possible cause for the transient slight proteinuria was the common febrile infection of the upper respiratory tract.

Miscellaneous

"Mongolian blue spots" were noted on the buttocks, sacrum, and left shoulder in one child; pigmented naevi were seen in five others, mainly on the chest or in the region of the scapula. Varicose veins were noted in one male and one female, both in middle age, the latter having varicose eczema as well. One male had onychogryphosis, another had a 4-in. (10-cm.) long keloid scar on his chest, and another had many lipomata scattered over his back, chest, and limbs. The vibration sense was found to be absent at the ankles (the only neurological abnormality we found) in a woman aged 85 and in two men aged 65. There was one example of twins—both males—among the Islanders. Serological tests were performed upon all the Islanders for syphilis*; the only positive was found in an old woman in good health.

Necropsy Findings

Four of the Islanders died in England, and the reports of three of the post-mortem examinations performed were

kindly made available by Dr. D. S. Ridley, of the Hospital for Tropical Diseases (two cases), and Dr. J. Amos, of Redhill General Hospital (one case).

Case 1.—A 67-year-old woman died of bronchopneumonia. Her aorta and coronary arteries showed only mild atheroma, and there was slight degenerative calcification of the aortic valve cusps. Young adult ascarides were found in the stomach and small intestine. The kidneys appeared unusually smooth and healthy for her age, and the brain, liver, and spleen were normal. In the lungs there was haemorrhagic confluent bronchopneumonia involving the greater part of all lobes of both lungs. There were two cavities 1 cm. across in the left upper lobe. The thyroid gland showed considerable infiltration with lymphocytes though no germinal centres were seen. There were scanty histiocytes.

Case 2.—An 82-year-old woman died of bronchopneumonia with a purulent laryngo-tracheo-bronchitis. She was obese. The heart was of normal size with a fatty pericardium. The coronary arteries were healthy and the aorta showed only moderate atheroma. The kidneys were smooth and normal apart from the presence of a few small cysts.

Case 3.—A 72-year-old man had suffered for three weeks from infective hepatitis and had gradually deteriorated. The mitral valve showed a few small areas of atheroma. Moderate atheroma was also present in the left coronary artery, but the right was remarkably free. There were some patches in the main pulmonary arteries, but minimal amounts in the aorta. Mild emphysema and extensive bronchopneumonia were present. The liver showed only fatty changes macroscopically, but contained several angiomas. The thyroid was atrophic. There was foetal lobulation of the otherwise normal kidneys, and the capsule stripped readily. The prostate gland was of normal size. The brain was normal apart from moderate atheroma where the vertebral arteries joined to form the basilar.

All three individuals showed little evidence of atheroma, and, apart from the lungs, the organs were remarkably healthy for their age. It is interesting that infiltration of the thyroid gland with lymphocytes was seen in one, as no goitre was detected nor evidence of hypothyroidism or hyperthyroidism found in a single living Islander.

Discussion

The investigation has revealed a widespread ill-health and the presence of congenital abnormalities. From past reports (Earle, 1832) we know that the health and fertility of the original settlers were good. For instance, one couple had 16 children. Their immediate descendants were also, apparently, healthy and free from disease. In 1885 Dr. Greany, Naval Surgeon in H.M.S. *Miranda*, recorded his visit in a personal diary.† There were then 102 Islanders, 11 of whom consulted him for various ailments. He saw a woman with chronic gastritis and "internal derangement," and another with an "irritable heart." Among the male patients one had rheumatic pains of the knee, another facial neuralgia, and one a lacrimal canal blockage. Otherwise all were very healthy. "The medicine chest sent out many years ago still contains a good stock . . . it may be inferred that the locale is healthy."

With the change from sail to steam, the world's trade routes had altered and from 1900 Tristan da Cunha became increasingly isolated. By 1910, however, asthma and night-blindness had been noted in the colony (Barrow, 1910). Epidemics of colds occurred whenever ships visited the island. A missionary's wife (Rogers, 1928) noted that many of the Islanders lived near starvation level and the infestation with *Ascaris lumbricoides* was very common. In 1923 A. H. Macklin, medical officer of Shackleton's ship, the *Quest*, visited the island and found asthma to be the com-

monest ailment (Wild, 1923). He found one woman with "dropsy and congestion of the lungs," and one man "dumb and strange." These findings were confirmed by Marshall (1926) and again by Sampson (1932). Purser (1933), from R.R.S. *Discovery*, again found asthma, together with one person with a cataract and another with dyspepsia. Barlow (1937) noted one man to have deformed pinnae associated with mental dullness and deafness; another had deformed arms. One Islander had had a haematemeses and melaena. Many of these findings were confirmed and described in greater detail by Woolley (1946).

Norwegian Expedition

In 1937-8 a Norwegian Scientific Expedition arrived on the island to carry out studies of the people themselves, their social structure, way of life, and the flora and fauna of the island group (Henriksen and Oeding, 1946). They found the Tristan boys smaller than their Norwegian counterparts, but healthy and without rickets or obvious nutritional deficiencies. The girls were less undersized than the boys. The adult males were, however, taller than the Norwegians and lacking in subcutaneous fat. The age of the menopause in women averaged 46.6 years (range 39 to 55 years). (We found it to be 45.9 years, range 36 to 50 years). They also found, as we did, that puberty in boys and the menarche in girls were reached somewhat later than is usual in Europe.

The most important illness noted was asthma, which they found to be common. One man had retinitis pigmentosa, associated with a cataract and night-blindness (this was the same man observed by Mrs. Barrow in 1910). They, like us, did not find a single case of goitre. They thought the intelligence of the Islanders as a whole to be normal. The blood-pressure range in the population by sex and age was similar to our finding. They noted one man to have phocomelia and mental dullness. There were two people with polydactyly. Another Islander had had recurrent haematemeses and melaena. One young woman had an absent left nipple, but the breast was normal. They noted that four people complained of hay-fever (we found only one), two women had chronic eczema, and another had angioneurotic oedema. They found one idiot with hyperextensibility of the joints and short thumbs. We found joint hyperextensibility existing as an isolated finding in one male and four females.

Our findings differed little from those of the Norwegians. We also found the children a little shorter than British children of the same age. Our investigation revealed a high incidence of asthma (48.5% of the adults) and of dyspepsia (22.7% of the adults), and several congenital abnormalities. We noted four Islanders to have retinitis pigmentosa, unassociated with cataracts, and perhaps 12 with choroido-retinitis. The blood-pressure range we noted was similar to that found by the Norwegians.

Comparison with Other Surveys

It is of interest to compare the prevalence of tightness of the chest and wheezing with that found in British surveys. Higgins *et al.* (1956) in Leigh near Manchester, an area of considerable air pollution, found a prevalence of chest tightness in 35.7% of those males who had never been coal-miners. This compares with the prevalence of 44.6% among the Tristan adult males. In the Leigh survey 29.8% of the males who were not miners complained of a chronic cough (61.4% of the adult male Islanders). Of these, 28% had mucoid sputum, whilst we found 24.8% of the male adult Islanders to have this symptom. If

†Kindly lent to us by his nephew, Dr. W. H. Greany, Lyndhurst, Hants.

comparison is made with an agricultural Scottish population (Higgins and Cochran, 1958) where air pollution was exceptionally low, as exists on Tristan, then 29% of the males had a chronic cough, and 23% had tightness of the chest—a much lower incidence than in the Tristan adult males. A similar disparity is obvious between the Islanders and the agricultural population of the Vale of Glamorgan (Higgins, 1957), where air pollution is also minimal. Higgins (1957) makes the point from his surveys at Leigh and Glamorgan that the industrial environment has a much smaller effect on the incidence of chronic bronchitis than might be expected. The pattern is the same, but the severity of symptoms is greater in the industrial areas. Clearly, at least two factors are at work, one environmental and the other probably genetic.

It is interesting that the prevalence of respiratory symptoms among the Tristan people is greater than that experienced by those living in air-polluted Lancashire. The atmosphere of Tristan is free of pollution by smoke particles, but we do not know what other environmental factors may have been at work. The high incidence of bronchospasm may be merely a reflection of the gross inbreeding that has occurred in the island. Smoking seems to increase the incidence of respiratory symptoms considerably (Higgins *et al.*, 1956). The prevalence of chronic cough (37.5%) among the population of London Transport workers studied by Fletcher and Tinker (1961), 75% of whom were smokers (32% smoked more than 15 cigarettes a day), more nearly approaches the prevalence of chronic cough (59.1%) among the Islanders than that encountered in the other surveys. The Islanders, however, were only moderate smokers.

Dyspepsia was another common complaint among the Islanders, involving 22.7% of the adults (27.7% of the males and 17.5% of the females). Doll *et al.* (1951) estimated that about 30% of the English population they surveyed complained at one time or another of dyspepsia—a very similar incidence to that on Tristan. Although dyspepsia seemed so common, there is no evidence that its incidence was any different from that found in England. Doll *et al.* found the incidence of peptic ulcer among all age-groups to be 6.5% in the English males they surveyed, and 1.7% among the females, giving a ratio of 3.8 to 1. Among the Islanders the ratio of males to females complaining of dyspepsia was 1.6 to 1. This was more like the ratio found in the English population of those aged 55 years or over. The average age of the Islanders complaining of dyspepsia was 42.2 years in the males and 42.3 years in the females. The overall incidence of dyspepsia on Tristan was therefore similar to that found in England, though rather more females were involved than might be expected. This may well be a reflection of the small numbers of Islanders involved (45), but it is perhaps improper to compare the figures for peptic ulcer with the figures for dyspepsia.

The range of casual blood-pressure readings among the Islanders was very similar to that found in other surveys (Hamilton *et al.*, 1954; Master *et al.*, 1950) in Europe and America. The blood-pressure tended to rise with age in both sexes, and the males had higher readings than the females until the age of 30. It dropped in the male until the age of 50, after which it steadily rose. This agrees closely with the findings of Hamilton *et al.* (1954). It is interesting that Maddocks (1961) did not find the usual rise with age nearly so great in the Melanesian and Micronesian populations of the Gau and Abaiang Islands in the Pacific. The Tristan Islanders come mainly of European stock, with some admixture of African blood, and their

blood-pressure follows the European and North American pattern rather than the Polynesian one.

The Islanders suffered little from abnormalities of the cardiovascular system. Only two of those with elevated casual blood-pressure readings had evidence of left ventricular hypertrophy, and only three had a mild hypertensive (grade II) retinopathy. The peripheral pulses could be felt in almost all of them, regardless of age, and the lack of atheromatous lesions was amply demonstrated at the three necropsies. A few Islanders had benign heart murmurs, and only two had congenital heart lesions. In one family there was a history of a relative dying of a stroke, but on the whole the Islanders were remarkably free from atherosclerosis and its complications. Investigations are in progress on their serum lipid levels and their nutritional history, with special reference to fat intake.*

Congenital Abnormalities

Considering the inevitably high incidence of consanguinity in this island population, it was expected that many congenital abnormalities would be seen. We were not able to ascertain the exact rate of consanguineous marriage, but it was many times higher than the incidence of 0.6% quoted for this country (Penrose, 1949). The incidence of congenital defects in this country is about 25 per 1,000 (Stevenson, 1961).

The congenital abnormalities found were listed as follows: congenital heart defect (2), hypospadias (2), retinitis pigmentosa (4), hypertelorism (2), micrognathia (1), polydactyly (1), and deafness/gothic-palate/mental-dullness/abnormal-pinna syndrome (36). This gives an incidence of congenital abnormalities of 185.3 per 1,000. Even if one excludes the deafness/dullness/palate/ear syndrome the incidence is still 38.6 per 1,000, which is nearly double the expected rate for a British population (*International Classification of Diseases*, 1957).

The isolation of the Islanders from contact with the outside world is well illustrated by the epidemics of colds that occur after each visit of a ship. Whenever exanthemata were accidentally introduced an epidemic ensued which affected all ages. This was well demonstrated by the incidence of measles among the population three years ago (63% of the adults and 57.4% of the children). The epidemic of jaundice affected 66% of the adults in 1961; there had been no previous epidemic of jaundice since about 1868.

When they were examined soon after their arrival the Islanders were cheerful, co-operative, and pleasant. They were apparently contented with their lot and free from anxiety. After a year in England they have become unhappy and distinctly anxious in their environment.

It remains to be seen whether these new factors alter their pattern of health, and how the congenital background changes if they continue as an inbred population.

Summary

In October, 1961, the Islanders of Tristan da Cunha (population c. 260) were evacuated to Britain. There was an opportunity for an extensive assessment of their state of health, and for an investigation and treatment of their disabilities. The general findings are described. Specialized investigations will be reported at a later date.

The Islanders looked young for their age and gave a history of delay in the onset of puberty and of the menarche. The children appeared underweight and small, but this was not apparent in adults. They had massive parasitic infection, which they accepted philosophically.

Compared with the population in Great Britain, they showed an increased incidence of asthma and congenital abnormalities, but a striking absence of atherosclerosis. In other respects—for example, complaints of dyspepsia, blood-pressure levels—they showed the same trends as the population of Britain.

Among the congenital abnormalities the incidence of retinitis pigmentosa is most serious.

The significance of these findings should be borne in mind if the Tristanians continue as an inbred and isolated community.

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CHROMOSOMES AND SERUM PROTEINS: A LINKED ABNORMALITY

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In recent years chromosome abnormalities have been reported in direct marrow preparations (Bottura *et al.*, 1961) and peripheral blood cultures (German *et al.*, 1961; Benirschke *et al.*, 1962) from patients with macroglobulinaemia. In the case reported by Bottura *et al.* (1961) the abnormal cell-line contained, in addition to the normal diploid complement, an abnormal large and almost acrocentric chromosome. In the other two cases the abnormal cell-line, with 47 chromosomes, comprised about 4% of the mitotic population of the cultures and the additional chromosome was a large metacentric or a submetacentric chromosome.

The relationship between the genetic abnormality and the biochemical defect in this disease has, up until now, not been clear. German *et al.* (1961) suggested that the biochemical abnormality may have induced the genetic damage; Patau (1961) did not agree with this view. We report one case of proved macroglobulinaemia in which a chromosomal abnormality was found and two further cases in which the incidental finding of chromosomal abnormality led to the discovery of dysproteinaemias. We believe that these three cases throw new light upon the relationship between these genetic abnormalities and the protein defect.

Case Reports

Case 1: macroglobulinaemia.—A man aged 66 presented with dyspnoea and cor pulmonale. On examination there was slight enlargement of both liver and spleen; there was no lymphadenopathy. The fundi oculi showed very full and tortuous veins but no haemorrhages. Blood count revealed a slight anaemia (Hb 8.2 g./100 ml.) but normal leucocyte and platelet counts. Sternal marrow biopsy revealed a moderately cellular marrow with all normal cell types represented, but in addition there were increased numbers of plasma cells, reticulum cells, and small lymphoid cells similar to those reported in cases of macroglobulinaemia. Serum globulin was 7.9 g./100 ml., and on electrophoresis there was an intense narrow band moving as a γ -globulin. The plasma solidified at 30° C. and the cryoglobulin test was strongly positive. Immunoelectrophoresis

and antiglobulin neutralization studies confirmed the identity of the abnormal protein as a γ -globulin. Ultracentrifuge studies were not successful owing to insolubility of the protein, but it was probably in the 19 Svedberg unit class. Treatment was instituted with chlorambucil (10 mg./day), and after five and a half months serum globulin concentration had fallen to 5.5 g./100 ml., and after eight months to 4.7 g./100 ml. Marrow biopsy at this time failed to reveal any excess of plasma cells or lymphoid cells.

Case 2.—A 24-year-old woman presented with increasing tiredness and pallor. She had given birth 10 months previously to a premature mongol infant who died after six months, and it was for this reason that the cytogenetic studies which revealed an abnormal chromosome were carried out. Nothing abnormal was found on either clinical or haematological examination. Owing to the presence of the abnormal chromosome serum protein studies were undertaken and a slight protein abnormality was found when serum was subjected to the antiglobulin neutralization test, which indicated a small increase in γ -globulin. The total amount of globulin present was, however, within normal limits (2.6 g./100 ml.). No macroglobulinaemia was found.

Case 3.—A 19-year-old woman had had recurrent purpura since the age of 17. Clinical and haematological examination at the time of study revealed no abnormality. Serum protein analysis at this time showed an increase in the amount of globulin (5.2 g./100 ml.), which was found by electrophoresis and the antiglobulin neutralization test to be due to an increase in γ -globulin. No macroglobulinaemia was detected. Because of the dysproteinaemia cytogenetic studies were undertaken.

Cytogenetic Studies

Cytogenetic studies were carried out on all three patients, using the peripheral blood-culture technique (Hungerford *et al.*, 1959). In Case 1 serial studies were made before treatment and after five and a half and eight months. A normal modal number of 46 was found in each case with no excessive degree of aneuploidy, although the percentage of aneuploid cells in Case 1 did increase during the course of treatment. These results are shown in the Table.