VETERINARY STUDIES ON THE BRITISH ANTARCTIC SURVEY'S SLEDGE DOGS: II. OCCUPATIONAL OSTEOARTHRITIS

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ABSTRACT. The results of an investigation into the problem of osteoarthritis in British Antarctic Survey sledge dogs are presented. Clinical, pathological and radiographical findings are described. The aetiology of the condition which shortens the working life of the majority of these dogs is discussed. The present evidence suggests that pressure due to pulling loaded sledges is the main factor causing acceleration of the degenerative changes due to ageing, and movement, of the main limb joints. No evidence was found of an hereditary basis for the condition.

Appendices are included on aspects of nutrition, on the discovery of spondylosis deformans and on the clinical treatment of osteoarthritis in British Antarctic Survey sledge dogs.

DOG-TEAM drivers of the British Antarctic Survey have come to accept the fact that otherwise healthy Antarctic sledge dogs are usually incapable of further work by the time that they are 8 years old. Since this is less than might be expected of a dog of the husky's size and weight under normal conditions, an investigation into the possible causes of the decline of the ageing husky was started in 1963–64.

This paper is intended to show the results of the investigation, undertaken during two austral summer tours of the Survey's stations by the authors in 1963–64 (M.F.G.) and 1967–68 (A.R.M.B.).

One season was devoted to a pathological survey of the dogs, particular emphasis being placed on the state of the articular surfaces of the joints, and another to a clinical approach involving X-radiography. From the latter, it was found incidentally that spondylosis deformans occurred to a small degree in the older dogs and the implications of this are discussed in Appendix I (p. 33).

HISTORY

In 1963–64 Godsal examined all the dogs at the stations, and destroyed 34 of them. Most of these dogs were incapable of further work, but some were destroyed because they were surplus to requirements. The main finding on post-mortem examination was erosions of the articular cartilage of the hip and shoulder joints. The results of this study led to the conclusion that no satisfactory hypothesis of the aetiology of the condition could be reached unless poor conformation of the affected joints was eliminated as a causal factor. Hip dysplasia, a disease thought to be hereditary, and known to affect certain breeds such as the Alsatian, Cocker Spaniel, Labrador Retriever and Alaskan Malamute, often gives rise to severe osteoarthritis of the hip. The condition is usually diagnosed by radiological examination of the hip, so that, although there was no other clinical evidence of hip dysplasia apart from the erosions, a portable X-ray unit was taken to Stonington Island in 1967–68. 29 Antarctic sledge dogs underwent radiological examination. In addition, slow-motion ciné film was made of the dogs drawing a sledge, and this was brought back to Cambridge to see if the unusual gait of the working husky might in itself be a factor resulting in the slowing of the ageing dogs.

The history and maintenance of the British Antarctic Survey's sledge dogs have already been summarized by Bellars (1969). This paper also shows that osteoarthritis is the reason for destruction for nearly 72 per cent of males and 52 per cent of females that survive beyond 5 years of age, excluding deaths due to accidents.

METHODS

1963–64

34 adult sledge dogs, ranging in age from 2 to 11 years (Table I), were destroyed using large intravenous doses of sodium pentobarbitone.* Following the intramuscular injection of

* Euthatal, May & Baker; Expiral, Boots Ltd.; Lethobarb, Loveridge.

4–8 mg. acetylpromazine* to restrain these strong exuberant animals, venepuncture was easily accomplished with one assistant.

TABLE I. AGE DISTRIBUTION OF GRAHAM LAND SLEDGE DOGS DESTROYED IN 1963–64

Age (yr.)	*Number of dogs*
2	1
3	1
4	0
5	4
6	6
7	6
8	6
9	5
10	3
11	2
	34

A history of each dog's working life was taken and ante-mortem examinations were carried out. Complete post-mortem examinations followed where time allowed, and in all cases the limb joints were opened and examined. In cases with obvious lesions of the articular cartilage, the heads of the relevant bones were cut off and immersed in 10 per cent formol saline for 4 days, after which they were sealed in polythene bags with a little formol saline and brought back to Cambridge. The specimens were radiographed and photographed, and they were then cut into slabs and processed for sectioning, staining and histological examination.

1967–68

A portable Watson MX2 X-ray machine, on loan from the School of Veterinary Medicine, University of Cambridge, was installed in the generator shed at Stonington Island. 25 adult sledge dogs and two pups were selected for radiography of pelvis and hips. Those selected were in three groups:

i. Aged less than 18 months.
ii. Aged more than 6 years.
iii. Three dogs of intermediate age, showing signs of premature "ageing".

All other dogs aged between 18 months and 6 years were regarded as being in their prime and sound, and thus unlikely to reveal abnormalities.

Despite the strange surroundings, with the noise and heat from generators, it was found that the dogs tolerated being positioned on their backs without sedation, and a satisfactory series of ventro-dorsal pictures was obtained. The quality of these was enhanced by the use of a polarizing grid, and fast tungstate screens.† Using the station 240 V supply, machine settings were 72·5 kV, 10 mAS and $\frac{1}{2}$ sec., using a medium-fast film.‡

* Boots Ltd.
† Kodak Limited.
‡ Blue Brand, Kodak Limited.

In addition, some lateral radiographs of the spine and of the shoulder joints were taken from 11 dogs in group (i) and six dogs in group (ii), respectively.

The exposed plates were developed and washed in the station photographic dark room, and were then re-washed thoroughly on return to this country. Since then several experts in the fields of orthopaedics, radiology and hip dysplasia have kindly scrutinized the plates, and their views have been incorporated with our findings.

Slow-motion ciné film was taken from the side, front and rear of a working team of sledge dogs. The results were analysed in this country to see if the gait of the working husky could predispose to erosions of hip and shoulder articular cartilage.

Results

Clinical findings

The clinical signs associated with this condition in these dogs were not dramatic. It had been generally accepted that most Antarctic sledge dogs were too old for normal work at 7–8 years, so some drivers did not notice anything that they considered was abnormal. It was possible to establish, however, that certain dogs were becoming progressively slower than their team mates, and this slowing-up was by far the commonest complaint from drivers. Actual lameness was not widespread, probably because the condition is insidious in onset and almost invariably bilateral. In advanced cases, muscle wasting was apparent about the affected joints and it was usually pronounced about the hips and pelvis. Some dogs appeared to walk stiffly with their backs arched, especially after a period of rest. Pain could be elicited when the hips and shoulders were flexed and in some cases when the back was pressed downwards. Pain in the shoulders was most pronounced when the forelimb joints were flexed; full flexion of all the forelimb joints occurs every time a dog is put into the close-fitting harness. In no case were the joints themselves swollen or painful. In one very advanced case, the dog cried out with almost every stride of his forelegs but it showed no signs of not wanting to work and never stopped pulling.

Some experienced drivers turn the occurrence of osteoarthritis in their team to good advantage, finding that these older dogs seem to be aware of their capabilities and settle down more quickly at the start of a day's work than the young impulsive members of the team, transmitting to them the skill in pacing-out their energies for a long haul. However, once a dog has begun to suffer clinically from osteoarthritis, it is generally found that the affected dog will not last for another full season of work.

Pathological findings

Osteoarthritis is a degenerative disease of joints, characterized by erosion of the articular cartilage, with eburnation of the underlying bone and periarticular osteophyte formation. It is progressive and the re-modelling of the bone underlying the eroded cartilage, together with the osteophyte formation, causes changes in the shape of the extremities of the affected bone (Jubb and Kennedy, 1963, p. 46–48).

In the present study the changes seen followed the above pattern. In general, the older huskies were more often affected than the younger ones, but the severity of the lesions was not necessarily more marked in the older dogs, and neither was there a straightforward relationship between the severity of the lesions and the clinical symptoms.

In all cases the joint capsule showed no apparent thickening. The synovial fluid was clear and did not contain any loose bodies, and therefore it was not examined microscopically. Macroscopic erosions of the articular surfaces confirmed the existence of osteoarthritis.

Of the 34 dogs destroyed, 26 were affected. Nine of these had osteoarthritis of the hips only, three had erosions of the head of the humerus only, and in the remaining 15 affected dogs both hips and shoulders were involved. In two dogs one elbow was arthritic and in one dog both elbows showed lesions. One dog was found to have osteoarthritis of one stifle joint. The youngest affected dog was a 3½-year-old female.

The erosions of the articular cartilage were found to be in a uniform position on the articular surfaces of the humerus and femur. They varied in size and depth, but were invariably bilaterally similar. On the surface of an affected humerus the erosion was on the caudal curvature of the articular cartilage; on the femur it was found on the dorsal aspect, extending cranially

and caudally in the more advanced cases (Figs. 1–4). Severe cases also showed smaller erosions on the opposing surfaces of the glenoid cavity of the scapula and the acetabulum (Fig. 5). These erosions are found, therefore, in the areas of greatest pressure when a dog is pulling, i.e. on the areas in direct opposition when a dog is leaning against the weight of the loaded sledge, with its limbs in extension retraction and, in the case of the hindlimb, slightly abducted.

Study at post-mortem examination and later showed that there was no evidence of shallowness of the acetabulum in any of the dogs examined. Likewise, the heads of femora and

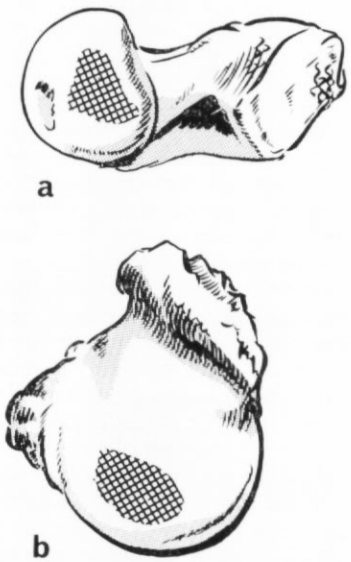

Fig. 1. Diagrams of dorsal views of (a) the head of femur, and (b) the head of humerus, showing the typical areas of erosion of the cartilage of an affected joint in the Antarctic sledge dog.

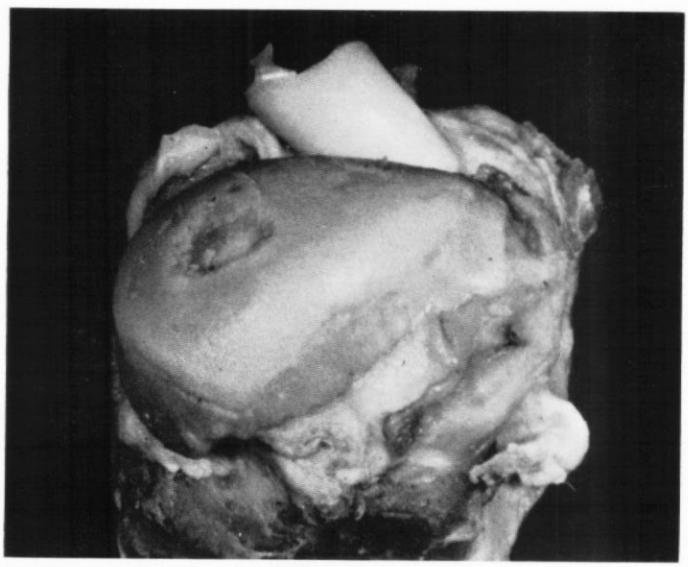

Fig. 2. A moderately affected humeral head from a female sledge dog (aged 8·2 years). There is lipping and osteophyte formation along the entire articular margin.

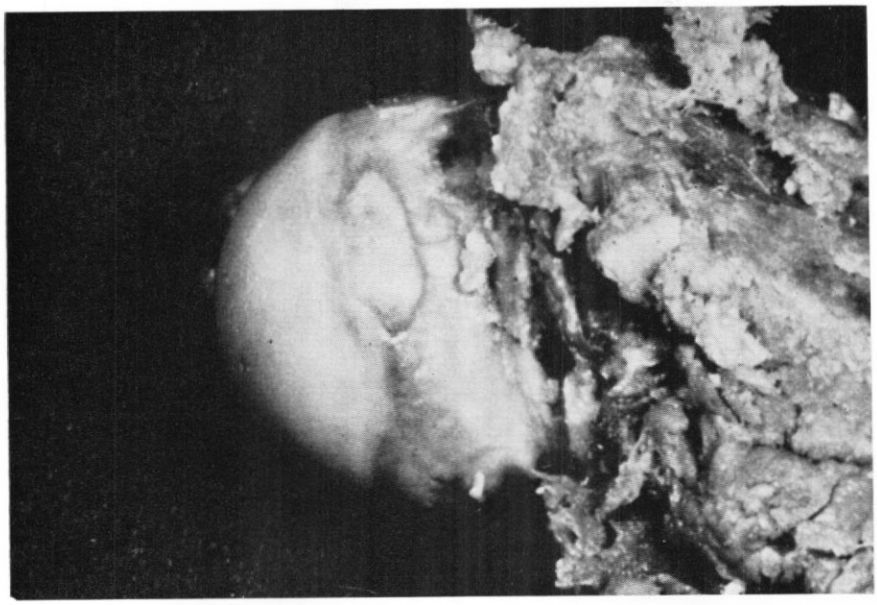

Fig. 3. A slightly affected femoral head from a female sledge dog (aged 6·8 years). There is a small osteophytic "blister" at the periarticular margin.

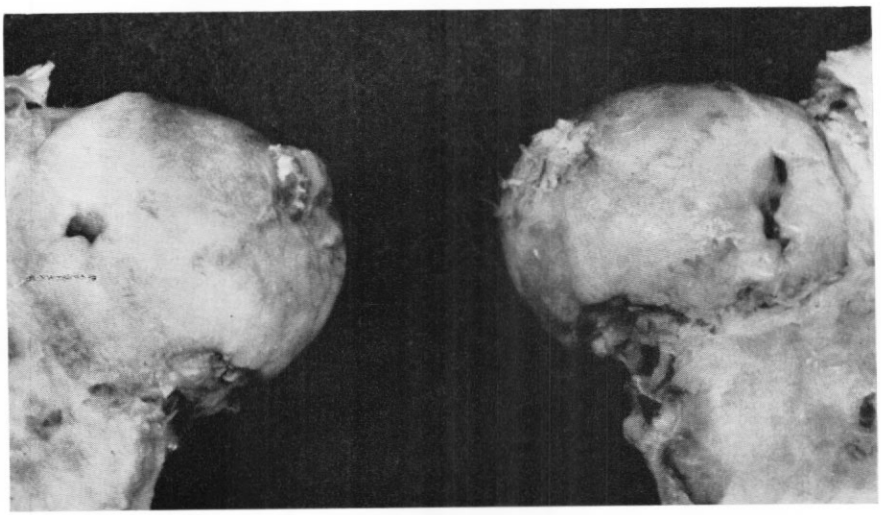

Fig. 4. The severely affected femoral heads from a male sledge dog (aged 9·1 years), showing extensive erosions and osteophyte formation.

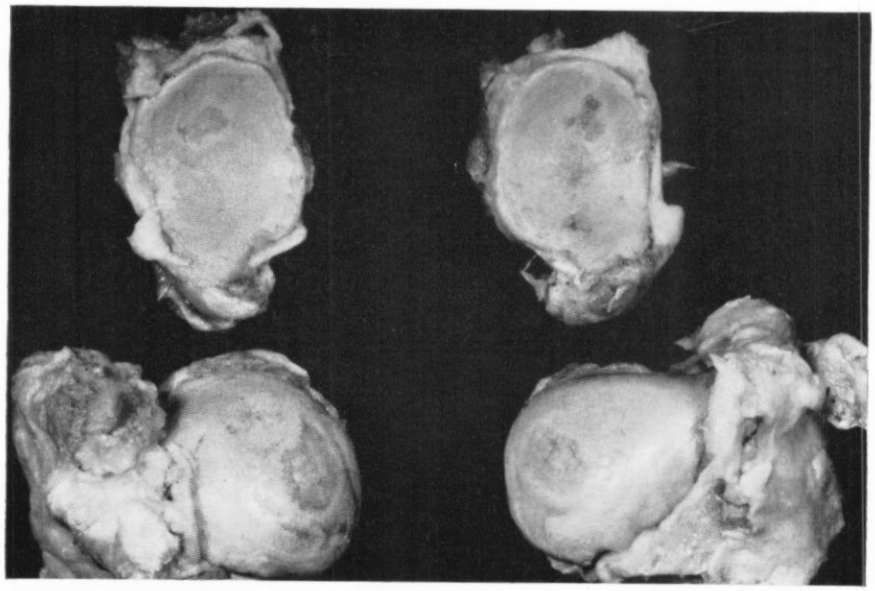

Fig. 5. The severely affected shoulder joints from a male sledge dog (aged 8·2 years), showing erosions of the humeral heads, with smaller erosions on the opposing surfaces of the glenoid cavities of the scapulae.

Fig. 6. A slab radiograph of a severely affected femur from a male sledge dog (aged 9·1 years), showing osteophyte formation at the periarticular margin and complete re-modelling of the femoral head and neck.

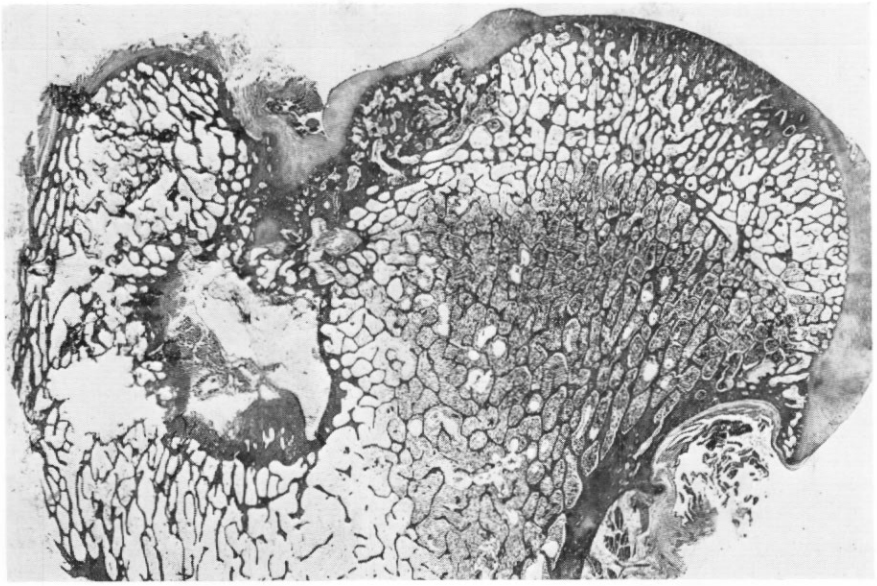

Fig. 7. Low-power photomicrograph of the same femur as in Fig. 6, showing exposure of the subchondral bone thickening of the bone trabeculae and re-modelling of the femoral head.

humeri showed normal conformation. There was some re-shaping in the most severely affected cases.

It is hoped that detailed results of the histopathology will be published elsewhere in the near future. Briefly, microscopy confirmed the macroscopic findings, revealing fissuring, fibrillation and erosion of affected cartilage; thickening of the underlying bone trabeculae and, in some cases, bone necrosis and periarticular osteophytes (Figs. 6 and 7). These findings varied in degree in proportion to the severity of the gross findings.

The macroscopic findings are summarized in Table II, from which we have drawn the conclusions given in Table III. From Tables II and III these results show that in the British Antarctic Survey sledge dog:

i. There is an increased tendency to osteoarthritis of the hip and shoulder joints with increased age.
ii. Severe cases can occur before 6 years of age.
iii. Some dogs are unaffected at nearly 8 years of age.
iv. All dogs over 8 years of age were affected.
v. Osteoarthritis of the hip joint is more common and occurs earlier in life than osteoarthritis of the shoulder joint.
iv. More than half of the affected dogs were affected in both hip and shoulder joints.

There is a possibility that the tendency of dog drivers to destroy females rather than males may suggest that these results and conclusions do not represent the clinical effect. However, as shown in a previous paper (Bellars, 1969), there is no statistical difference between the dogs destroyed here and those destroyed because of assumed osteoarthritis.

These findings show that the slowing and stiffening seen in the ageing husky is due to osteoarthritis of the hip and shoulder joints. The post-mortem appearance of some of the joints makes it remarkable that the affected dogs were willing to pull a sledge at all.

TABLE II. INCIDENCE WITH AGE OF OSTEOARTHRITIS IN THE HIP AND SHOULDER JOINTS OF BRITISH ANTARCTIC SURVEY SLEDGE DOGS

Sex	*Age at necropsy* (yr.)	*Lesions of osteoarthritis in:*	
		Hips	*Shoulders*
Male	1·8	—	—
Female	3·4	+	—
Female	5·2	—	—
Female	5·2	+	—
Male	5·3	—	+
Female	5·3	+	—
Female	5·8	+++	+
Female	6·0	—	—
Female	6·3	—	—
Male	6·4	+++	+++
Female	6·8	+	—
Female	6·8	+	—
Female	6·9	+	—
Male	6·9	—	++
Male	7·1	—	—
Female	7·1	+	—
Male	7·6	—	—
Female	7·6	—	—
Female	7·9	—	—
Male	8·1	+	+
Female	8·2	++	++
Female	8·2	+	+
Female	8·2	+	+++
Male	8·2	+	+++
Female	8·5	+	+
Male	8·7	+	+
Male	9·1	+	—
Male	9·1	+++	—
Male	9·4	+	+++
Male	9·6	+	++
Male	9·9	++	++
Male	10·2	—	+++
Male	11·0	+	+++
Male	11·7	+	+

Brackets denote siblings.

The lesions are divided into four categories, based on their macroscopic appearance at necropsy:

+++ Severe. + Slight.
++ Moderate. — Nothing abnormal detected.

The severe group showed extensive erosions. On the head of the humerus they involved nearly two-thirds of the articular surface. This group also showed large periarticular osteophytes. The other groups were progressively less affected with all these changes.

TABLE III. DISTRIBUTION OF OSTEOARTHRITIS OF HIP AND SHOULDER JOINTS IN 34 BRITISH ANTARCTIC SURVEY SLEDGE DOGS

	Average age (yr.)	*Total* (♂; ♀)	*Percentage of total dogs examined*
Total number of dogs examined *post mortem*	7·5	34 (17; 17)	100
Dogs unaffected with osteoarthritis	6·2	8 (3; 5)	23·5
Dogs affected with osteoarthritis	7·7	26 (14; 12)	76·5
Dogs affected in hips only	6·7	9 (2; 7)	26·5
Dogs affected in shoulders only	7·4	3 (3; 0)	8·8
Dogs affected in both hips and shoulders	8·7	14 (9; 5)	41·2

TABLE IV. RESULTS OF RADIOGRAPHY OF PELVIS AND HIPS OF BRITISH ANTARCTIC SURVEY SLEDGE DOGS

Serial number	*Sex*	*Age* (yr.*)	*Ventrodorsal position*		*Joint conformation*
			Right hip	*Left hip*	
1	M	1½ months	N.A.D.	N.A.D.	Normal
2	M	1½ months	N.A.D.	N.A.D.	Normal
3	M	9 months	N.A.D.	N.A.D.	Normal
4	F	10 months	Slight evidence of increased joint space		? Normal
5	F	10 months	Acetabular fossae slightly shallower than those of sibling		Normal
6	F	11 months	N.A.D.	N.A.D.	Normal
7	M	11 months	N.A.D.	N.A.D.	Normal
8	M	11 months	N.A.D.	N.A.D.	Normal
9	M	1·2	N.A.D.	N.A.D.	Normal
10	F	1·2	Slight evidence of increased joint space	Left acetabular fossa slightly shallower than right	? Normal
11	M	1·2	N.A.D.	N.A.D.	Tilted plate
12	M	1·2	N.A.D.	N.A.D.	Normal
13	M	1·3	Signs of erosion of femoral head cartilage		Normal
14	M	1·5	N.A.D.	N.A.D.	Normal
15	M	1·6	Signs of erosion of femoral head cartilage		Normal
16	M	3·6	N.A.D.	Slight signs of erosion of femoral head cartilage	Normal
17	M	5·0	Signs of erosion of femoral head cartilage Small osteophytes on acetabular margins		Normal
18	M	5·0	Signs of erosion of femoral head cartilage		Normal
19	M	5·8	N.A.D.	N.A.D.	Tilted plate
20	M	5·8	N.A.D.	N.A.D.	Blurred due to movement
21	M	6·0	N.A.D.	N.A.D.	Normal
22	F	6·0	N.A.D.	N.A.D.	Normal
23†	M	6·3	N.A.D.	Signs of erosion of femoral head cartilage	Normal
24†	M	6·6	N.A.D.	N.A.D.	Normal
25	F	6·9	Sign of erosion of femoral head	N.A.D.	Normal
26	F	6·9	N.A.D.	N.A.D.	Normal
29†	M	10·3	Very slight signs of erosion of femoral head cartilage; acetabular exostosis		Normal

Brackets denote siblings.

* Except where otherwise indicated. † Dogs showing clinical signs of osteoarthritis.

N.A.D. Nothing abnormal detected.

The conclusion is that there is no relationship between the radiograph and the clinical picture. These pictures confirm the absence of clinical signs of hip dysplasia in the British Antarctic Survey sledge dog.

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Radiographic findings

All the plates except one were of satisfactory photographic quality. Several showed slight faults due to positioning, e.g. tilting of pelvis, and a few were slightly hazy due to movement of the subject. Overall, the results were adequate for judgement of conformation and in many cases for assessment of small pathological lesions. These were gratifying results considering the circumstances under which the plates were taken, since this was basically a study of conformation.

The hip joints showed no evidence of sufficient abnormality to be called hip dysplasia. One female aged 10 months and another aged 14 months showed slight differences in conformation when compared with the other dogs. Several of the older dogs showed slight irregularities compatible with erosions of the articular cartilage of the femoral head and these were usually bilateral. Two dogs showed slight re-shaping of the hip joint with the formation of small osteophytes. The overall finding is one of normality with some dogs showing very slight degrees of pathological change (Figs. 8–11).

Too few pictures were taken of the shoulder to provide satisfactory conclusions. Of the six taken, all in aged dogs, two were of a sufficient standard to show slight erosions of the caudal surface of the humeral head (Fig. 12). The shoulder joints showed normal conformation.

The results of radiography of hips and shoulders are summarized in Tables IV and V. The results of radiography of the spine are discussed in Appendix I (p. 33) on spondylosis deformans.

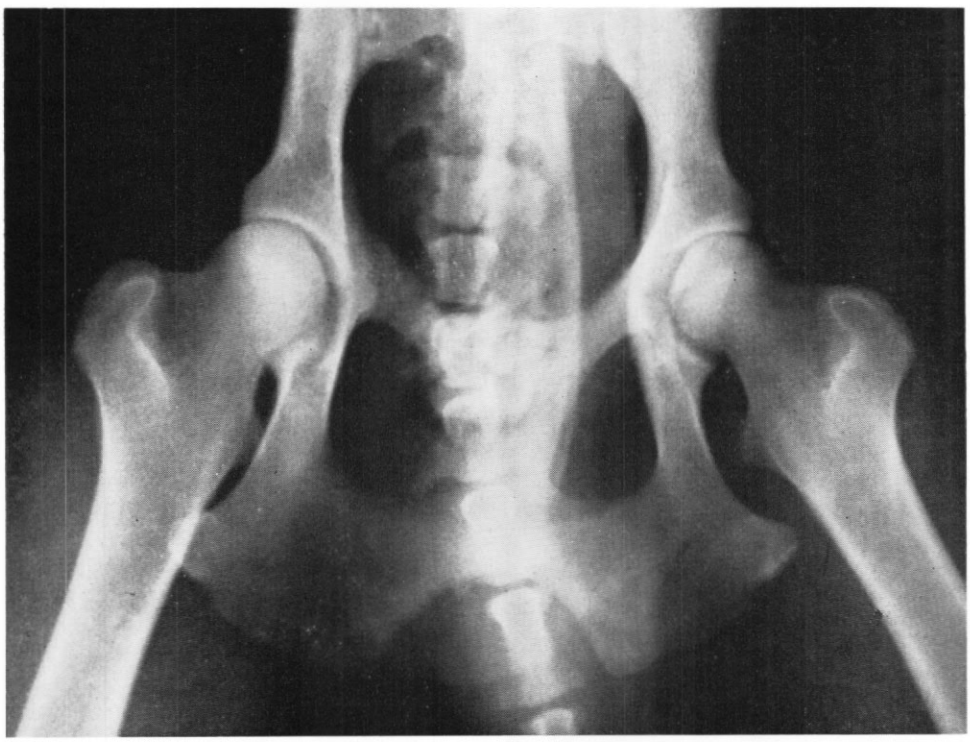

Fig. 8. Radiograph of hips and pelvis of a male sledge dog (aged 1·5 years) (Serial No. 14), showing complete normality.

Fig. 9. Radiograph of hips and pelvis of a female sledge dog (aged 10 months) (Serial No. 4). Although the acetabular fossae are slightly shallower than those of a sibling (Serial No. 5), the conformation of the joints falls between normal limits.

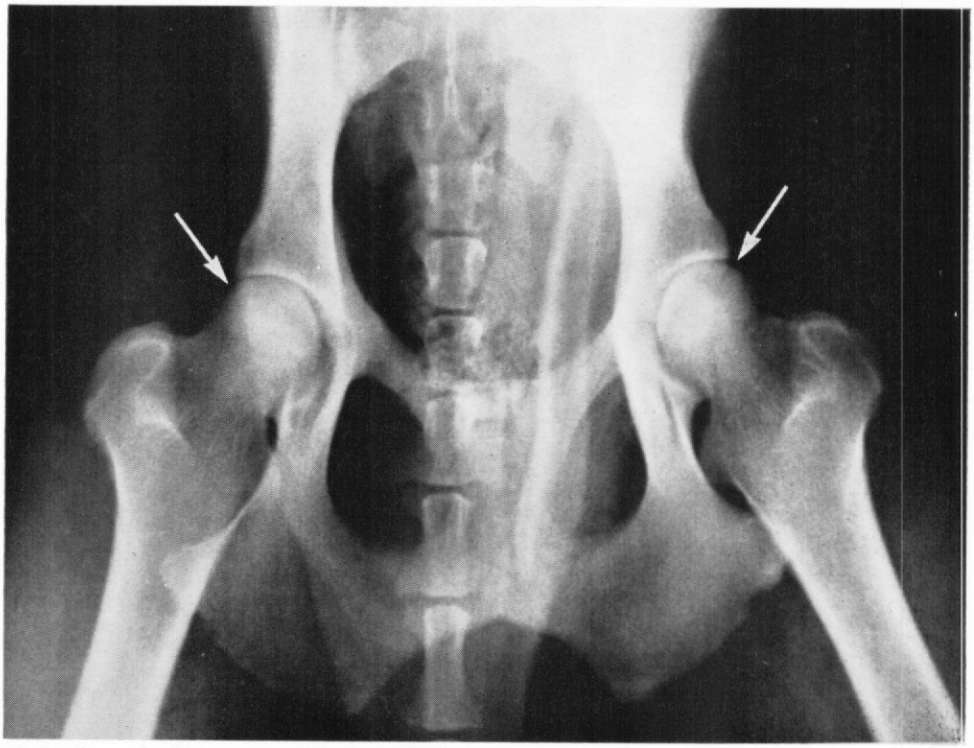

Fig. 10. Radiograph of hips and pelvis of a male sledge dog (aged 1·3 years) (Serial No. 13), showing signs of very small erosions of the femoral heads (arrowed).

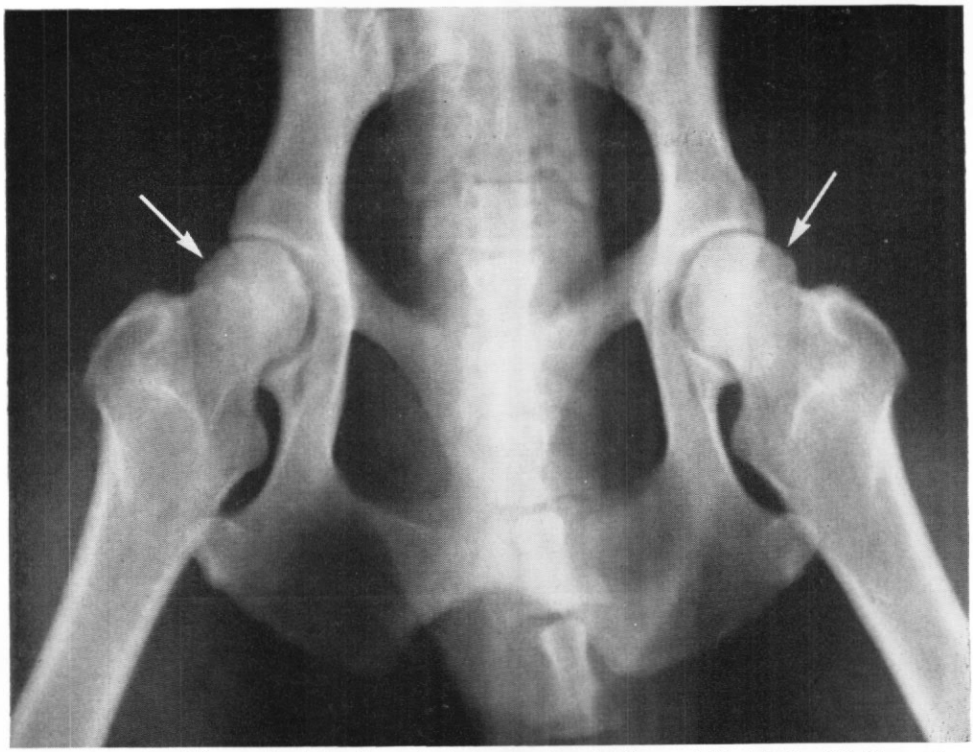

Fig. 11. Radiograph of hips and pelvis of a male sledge dog (aged 5·0 years) (Serial No. 18). Signs of erosion are arrowed.

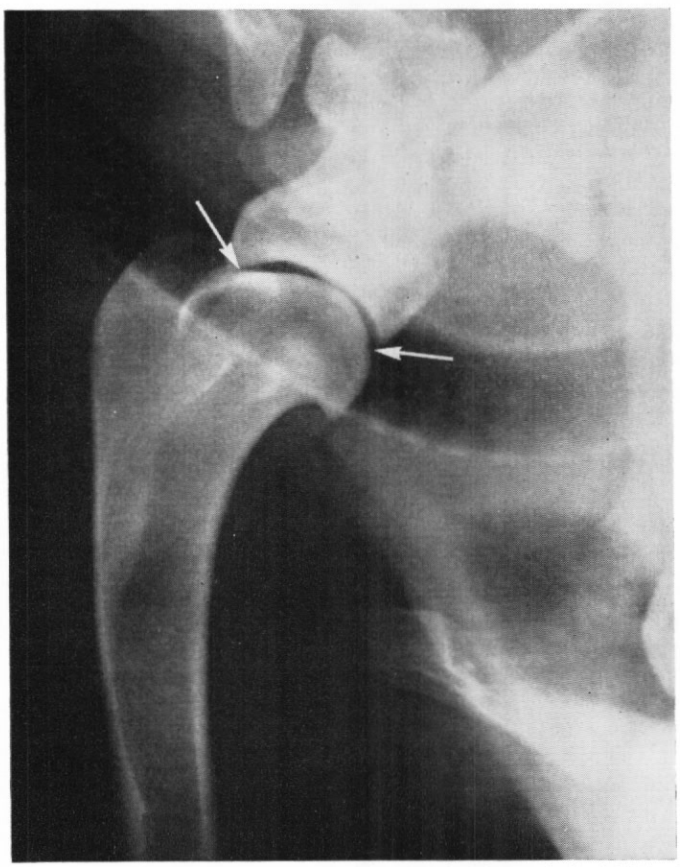

Fig. 12. Radiograph of the left shoulder of a male sledge dog (aged 6·3 years) (Serial No. 23), showing signs of slight erosion of the humeral head (arrowed).

TABLE V. RESULTS OF LATERAL RADIOGRAPHY IN BRITISH ANTARCTIC SURVEY SLEDGE DOGS

Serial number	*Lateral plate of shoulder*
17	N.A.D.
21	N.A.D.
23	Left shoulder showed signs of small erosion of caudal surface of humeral head
24	N.A.D.
28 (F; 8·2 yr.)*	N.A.D.
29	Both shoulders showed evidence of periarticular osteophytes on the caudal margin of the glenoid. Signs of past detachment of cranial part of the glenoid

N.A.D. Nothing abnormal detected.
* Affected clinically with osteoarthritis.

Findings from ciné film

The husky adopts a different gait while pulling a sledge, although when allowed to run free it will move as any other dog. By studying the slow-motion film, it is clearly seen that the working husky restricts spinal movement in the horizontal plane so that its spine is held relatively rigid. In this reduction of "anticlinal" movement the husky can be said to be mimicking the naturally more rigid spine of the horse (Slijper, 1946).

The husky also has a pronounced, stiff "waddling" movement of the hindquarters (to be distinguished from the looser "rolling" associated with hip dysplasia), and abducts its hindlimbs so that its hind feet are placed wider apart than normal (Fig. 13). The series of diagrams drawn from individual frames of the film shows this movement.

From the film, the pelvis shows minimal movement in the vertical plane when each leg in turn is protracted (brought forward) as the dog leans into the harness. Since it can be assumed that the pelvis is "fixed" at the hip when a hindlimb is fully weight-bearing and that the sacro-iliac junction is virtually immobile, it follows that as protraction commences there is bending of the spine away from that side and rotation of the spine about its longitudinal axis. The probable site for this rotation of the spine is high up in the thoracic region. It would appear that this combination of movements produces the peculiar gait, and also gives the dog great mechanical efficiency and purchase with which to pull for long periods.

Comparison of the radiographs with a normal femur shows that when the dogs were positioned for radiography, the hindlimbs were extended and *ad*ducted in contrast with the "pulling" stance, and that this has exposed part of the femoral articular surface to tangential exposure on the film. By further comparison with the post-mortem specimens, this positioning can be shown to have exposed the edge of the eroded areas. It is therefore concluded that the irregularities of the femoral articular cartilage seen on radiography are erosions and not exostoses.

The forelimb movements, as seen on the film, are different from those of the hindlimbs. The dogs appear "bandy-legged" while pulling with the forepaws placed nearer to the mid-line than would be the case in a normal standing position. Each foreleg in turn is swung outwards during protraction, before the paw comes inwards to be placed on the ground. Presumably this is because dogs are incapable of more than slight adduction of the forelimb. Thus, in order to achieve easy and efficient protraction, the leg is *swung* outwards to assist the weak adductor muscles against the antagonism of the muscles of abduction.

DISCUSSION

The results show that osteoarthritis of the hip and shoulder joints is the cause of decline of the majority of the Survey's older sledge dogs and that hip dysplasia does not occur in a

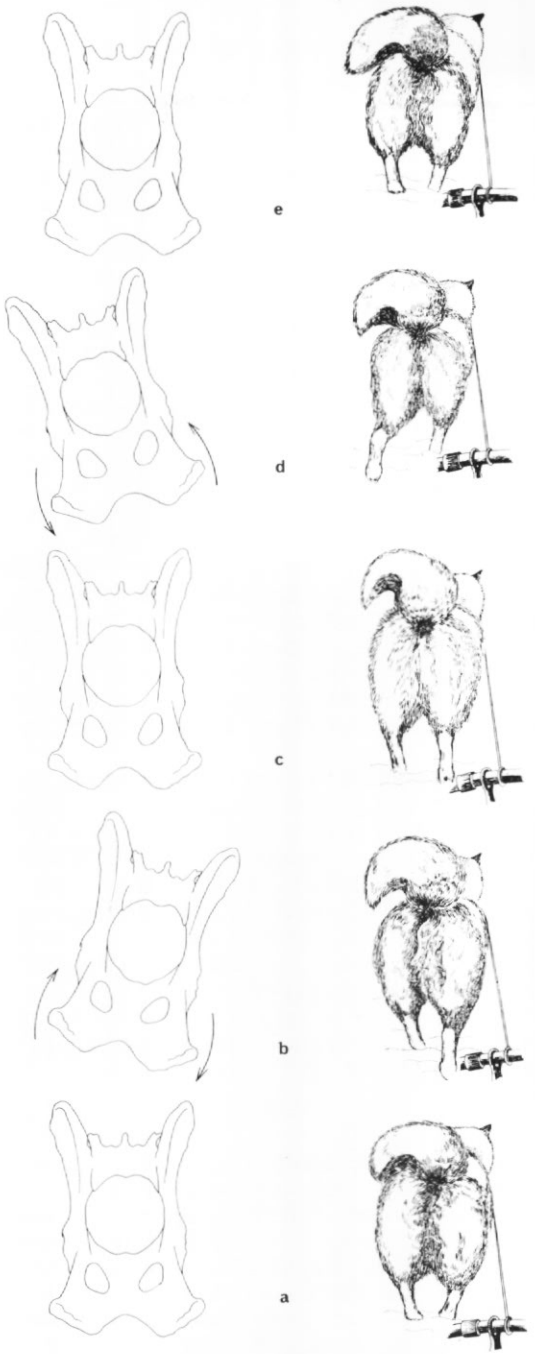

Fig. 13. Diagrams and drawings from slow-motion ciné film to show the hind limb gait of a working husky. The limbs are abducted to give the widened stance allowing greater purchase for thrusting. The pelvis rotates in a horizontal plane as shown. The progression commences from the bottom picture and proceeds upwards.

a. Left leg finishing swing forwards and about to start thrust phase. Right leg finishing support phase and about to commence thrusting. Pelvis aligned in direction of dog's movement.
b. Left leg supporting full weight. Right leg has finished thrust and is about to swing forwards. Pelvis rotated to the left.
c. Left leg beginning thrust phase. Right leg swinging forwards. Pelvis aligned in direction of dog's movement.
d. Left leg has finished thrust and is about to swing forward. Right leg supporting full weight. Pelvis rotated to the right.
e. Similar to (a).

representative selection of these dogs. This discussion assesses the possible factors that may be concerned in the aetiology of the condition, particularly the normal processes of ageing, the effects of pressure on weight-bearing joints, the loads that may be taken on the joints of sledge dogs and the effects of the Antarctic environment. The discussion also refutes the argument that osteoarthritis of the hip joint of the dog should immediately lead to a tentative diagnosis of hip dysplasia.

Ageing

Articular changes take place in ageing animals. In the young animal, articular cartilages are relatively thick, bluish white and translucent. With age the cartilage becomes thin, yellowish white and opaque. The changes in the joint follow the same pattern as seen at various ages in the Antarctic husky. Surface defects in the cartilage develop particularly in the weight-bearing areas. Clefts and ulcers follow, leading to erosion, exposure of underlying bone, and proliferation of hyaline cartilage, fibrocartilage and bone at the edges of the articular surface to give lipping and osteophytes (Jubb and Kennedy, 1963, p. 46–48). Considerable study in man has revealed similar changes (Davies, 1961, p. 30), and Bennett and others (1942, p. 19–40) showed that the earliest signs of degeneration of the knee joint in man could be found in all beyond the second decade of life. To emphasize this view that degenerative disease of the synovial joints is part of the physiology of ageing, many writers prefer to use terms other than osteoarthritis to describe it, e.g. hypertrophic arthritis (Davies, 1961, p. 30), arthropathy (Jubb and Kennedy, 1963, p. 46) and atrophy (Runnells and others, 1960, p. 622). In the context of this paper the term osteoarthritis describes the end point of a degenerative process.

Thus, age is considered here as a primary cause, since it is not only related to senescence of the joint tissues (Beneke, 1925) but also offers the opportunity for long continued trauma (Miller, 1933).

However, age alone is not responsible for the changes seen in the husky. The normal life span of these dogs is not known exactly, but estimates based on dogs reared in this country and on dogs brought back from polar regions suggest 9–13 years with an upper limit of about 15 years. The shortened life span of the Antarctic dogs, some of which are quite young when clinically affected with osteoarthritis (Bellars, 1969), therefore suggests a considerable degree of pathological (as opposed to physiological) degeneration. Concerning the possible contributory factors, the occurrence of osteoarthritis throughout the population enabled us to rule out infections, hormonal disturbances, gross trauma and individual congenital or adaptational deformities, and our own examinations of the dogs confirmed this. From the predisposing factors known to lead to osteoarthritis in man and animals (Davies, 1961, p. 31; Jubb and Kennedy, 1963, p. 48), abnormal conformation, special occupational activities, abnormalities of gait and changes due to nutrition are left for consideration.

Joint conformation

Osteoarthritis often occurs in young or middle-aged dogs as a result of joint dysfunction. Thus, degeneration of the stifle joint is often seen after rupture of the anterior cruciate ligament or luxation of the patella. Degeneration of the hip joint can accelerate following dislocation, fractures, epiphyseal shift or ischaemic necrosis, but it is most commonly seen in the United Kingdom as a result of hip dysplasia. This condition has become a widespread and major problem with many breeds of dogs in this country but there is still doubt about its aetiology (Månsson and Norberg, 1961; Whittington and others, 1961; Hickman, 1964, p. 318–25; Riser and others, 1964; Pierce and others, 1965; Henricson and others, 1966; Pierce and Bridges, 1967; Riser and Shirer, 1967; Bardens and Hardwick, 1968; Lawson, 1968; Paatsama and others, 1968). Because many affected dogs give no outward signs of hip dysplasia, radiographic examination is the only means available to show whether a dog may be regarded as having normal hips. This examination is, however, purely a diagnostic test and, since the problem is usually not so much one of diagnosis as confirming that the dog's hip joints are normal, strict attention should be paid in each case to the history, the clinical features and the breed (Hickman, 1964, p. 324).

A dog breed affected with hip dysplasia to the extent of the Labrador Retriever or Alsatian

will typically show occasional litters of puppies unable to walk due to subluxation of the femoral head, dogs 1–3 years old completely crippled with osteoarthritis, and many dogs showing gross deformities with secondary degenerative changes of the hip joints on radiological examination. The combined histories of 700 of the Survey's sledge dogs reveal no instance of these symptoms, or of the typical gait associated with hip dysplasia, i.e. "swaying" or "rolling" of the hindquarters. With only two exceptions, osteoarthritis of the Antarctic sledge dog is not seen in the younger animals but it occurs clinically at a peak of $7\frac{1}{2}$ years of age, often in both hip *and* shoulder joints.

At the other end of the scale, many dogs of a breed affected with hip dysplasia might show such slight dysplastic change that the only signs seen on radiological examination are those of re-modelling due to osteoarthritis. It is this fact that has probably led to the frequently expressed and, in our opinion, misconceived statement that all such cases of osteoarthritis are due to abnormal conformation such as hip dysplasia. An attitude such as this may be necessary when an investigation is carried out on a dog of a breed known to suffer from hip dysplasia but, in the light of present knowledge of the Antarctic sledge dog, takes no account of the history, the findings of normal acetabular shape on post-mortem examination, the radiographs or the fact that osteoarthritis of the shoulder is as common as that of the hip. In this connection, Campbell (1968), in a study of shoulder lameness of the dog at Glasgow Veterinary Hospital, reported that osteoarthritis of the shoulder was uncommon and that such cases as occurred were usually the result of trauma such as dislocation or fracture. His findings contrast with those observed in Antarctic huskies, where shoulder osteoarthritis is common and dislocation or fracture of the shoulder is very rare.

By virtue of these findings, and the conformation shown on the radiographs, we feel justified in believing that hip dysplasia, as seen in dogs in the United Kingdom, is not present in the Survey's sledge dogs. Such degenerative changes as are apparent are considered to be secondary changes due to ageing, exacerbated by "special occupational activities" and "abnormalities of gait".

Occupational activities

A mature Antarctic husky is expected to draw more than its own body weight on most sledge journeys. To give an estimate of the force that may be transmitted to the main limb joints, one should start with the work by Taylor (1957), who showed that the individual pull on a loaded sledge averaged 6 kg./dog for 9 min. when measured on one occasion. This pull would be largely passed via the harness to the shoulders and hips, and the force on the joints would be greatest when the limbs were in the position of maximum thrust. This matches the post-mortem findings, which show erosions not on the surfaces opposed during normal standing but on those in opposition at extension retraction. Lanyon and Smith (1969) have shown in sheep that the strain on an individual tibia *in vivo* is greatest when the limb concerned is taking full weight while the animal is walking. Paul (1965, p. 379) has shown in man that the total force on the hip joint with the subject standing stationary on one leg may be 2·5 times the total weight of the subject, but that when the subject was walking the force registered on the hip reached a peak of 5·8 times the total body weight. He has suggested that the major part of this walking load is due to muscular action.

In the working husky, the force is spread over the four main limb joints but the resulting diminution in the total load on any one hip or shoulder joint will be reversed by the extra load due to the pull on the sledge. From Paul's results it is reasonable to suppose that the resultant force transmitted to the hip or shoulder of a working husky would be far greater than the 6 kg. pull measured by Taylor.

This great force that the limb joints of a husky have to bear must be implicated in the aetiology of the osteoarthritis. Bennett and others (1942), Collins (1939) and Trias (1961) all found that cartilage surface defects and degeneration develop especially in the areas subject to weight-bearing and movement. The intercellular matrix of articular cartilage is made up of collagen and chondroitin sulphate, and it is the latter mucosubstance that gives hyaline cartilage its resilience and powers of diffusion. Matthews (1952, 1953) found that the ratio of chondroitin to collagen was higher in weight-bearing joints. He also found that the chondroitin sulphate content of human knee cartilage was higher than that of the shoulder. With

degeneration there was an increase in the collagen/chondroitin ratio and the development of fibrillation of the cartilage paralleled the loss of the mucosubstance. This then led to decreased resilience, which gave way to flattening, increased pressure effects, and increased wear and tear. This process is applicable to the accelerated degenerative changes taking place in the Antarctic dogs.

Trueta (1956, 1960) and Trias (1961) have not only emphasized the effect of weight-bearing on joint degeneration but have also pointed out that osteoarthritis is brought about by interference with the vitality of the chondrocytes, and that this is commonly achieved by wrongly distributed and intermittent pressure. Although weight-bearing areas show the development of degenerative changes, the work of Harrison and others (1953) showed that the primary change in articular cartilage took place in the non-weight-bearing areas and consisted mainly of hyperplasia of the cartilage, leading to chondromalacia. Thus it may be that the occurrence of osteoarthritis depends not so much on weight-bearing on so-called normal areas but on weight-bearing on areas of joint cartilage not normally subject to pressure. This may be due to anatomical anomalies, of which the Antarctic sledge dog shows no signs, or to incorrect joint function causing undue compression on part of the articular cartilage and insufficient compression on the remainder. If, as has been suggested, the Antarctic sledge dog adopts an unusual posture while pulling, this abnormal gait will induce faulty joint function. In addition, the life of the dogs is such that hard-pulling efforts alternate with "lie-up" periods of bad weather, periods when the dog drivers are working in the field away from the team, and long spells of relative idleness at the scientific station. It is probable that this alternation between extreme effort and rest is an important factor leading to the articular changes.

The effects of pressure and postural changes have been implicated in the possibility of ischaemia of articular structures. Articular cartilage itself is devoid of blood vessels except in the very young and very old. It was suggested by Walmsley (1915) that the arterial supply to the head of the femur in man was reduced with age. However, Harrison and others (1953) found a copious blood supply and free anastomosis even in old age, and Roberts (1955) found no evidence to support the view that osteoarthritis of the human hip is often due to ischaemia of the femoral head. Against this, Trueta and Trias (1961) found in the rabbit that after about 14 days of severe continuous pressure on the stifle joint there was irreversible interference with growth of the epiphyseal cartilage due to compression damage and interruption of the blood supply. Hall (1963) showed in similar experiments on the young rat that the articular surfaces of young animals were able to stand considerable compression without becoming necrotic and that this ability was retained even in maturity. Thus the evidence suggests that interference with the vascular epiphyseal cartilage is easier to achieve than interference with the relatively non-vascular articular cartilage. In this respect, the intermittent high pressure on the main limb joints of the Antarctic husky could lead to changes in the epiphyseal cartilage, particularly in the growing animal. It is therefore most important that the musculo-skeletal system of the Antarctic dogs should be allowed to mature before they are expected to haul heavy loads.

Nutrition

The work of Taylor and others (1959) dealt with some aspects of the vitamin content of the sledging diet Nutrican,* but it did not cover the effect of nutritional factors on the musculo-skeletal system. Our examinations showed that Antarctic sledge dogs had no clinical symptoms that could be associated with calcium or phosphorus deficiency, and it is assumed that the dogs acquire adequate supplies of these minerals from eating seal meat and bone. In addition, there were no signs of vitamin deficiencies, although for some years there have been reports from the stations of a skin condition which has the appearance of being due to a nutritional disturbance (see Appendix II, p. 35). In short, it would appear that the diet of these dogs is not implicated in the occurrence of osteoarthritis.

Environment

The husky is so well adapted to its environment that it is not easy to decide which factors may play a part in its decline. The Eskimo regards wolf blood as a desirable trait in his dogs

* Bob Martin Limited.

but it appears that even the wolf is subject to osteoarthritis, since Cross (1940) found extensive osteoarthritic lesions in two aged timber wolves in northern Canada. Almost all the joints, including the intervertebral joints, showed osteophyte formation but the details of the pathology were not given.

The sleeping position of the dogs is characteristic. They lie curled up on their sides in the snow with the tail wrapped round the face and paws, thereby conserving the heat given off from their bodies. In this position, the hip and shoulder joints, and to some extent the elbow and stifle joints, are in closest contact with the snow surface. Hunter and Whillans (1951), while investigating stiffness in joints and the decrease in manual dexterity in cold weather, found a significant fall in joint temperature in a cat exposed to zero and sub-zero temperatures, while the fall in body, muscle and average skin temperatures was less than the fall in joint temperature. It is not known whether this finding is a factor to be considered in the aetiology of osteoarthritis. In the husky, the superlative insulating properties of its coat may render it immune to temperature changes at or under the skin surface at most ambient temperatures encountered in the Antarctic. However, most Antarctic sledge dogs will shiver violently and show marked reluctance to rise to their feet at temperatures below −40° to −45° C. At Halley Bay, it is now accepted that one or two of the older dogs will die during the winter, if left on the snow surface, due to exposure to temperatures down to −50° C. These extreme conditions must have a detrimental effect on the physiology of the Antarctic sledge dog but it has not been possible to co-ordinate this with osteoarthritis.

Labrador

In the autumn of 1965, one of us (M.F.G.) spent a short time in Labrador during which it was possible to examine a number of live Eskimo and Indian sledge dogs. Two bitches and one dog were destroyed and post-mortem examinations were carried out. The bitches were said to be aged 12 and 13 years, respectively, and the dog was 4 years old. In both of the old animals the femoral and humeral heads had deep erosions of the articular cartilage in the same areas as in the Antarctic dogs, and the opposing acetabular and scapular surfaces were also eroded. Periarticular osteophytes were found and the joints were classified as moderately affected. In the young dog the shoulder joints showed no abnormality; the hip-joint articular cartilage showed slight roughening in the weight-bearing areas but no deep erosions were found. The histopathological pattern was similar in all respects to that found in the Antarctic dogs. All other tissues were apparently normal.

In this part of Labrador, around Goose Bay, the husky dogs are not used so continuously as the dogs in the Antarctic. In winter, local journeys are made to collect timber and fuel. The diet of these dogs is mainly dried fish but in winter they are occasionally given caribou or moose. Most of the local people agreed that the upper limit of a Labrador husky dog's working life was between 8 and 10 years. Although no firm conclusion could be reached, it seemed that osteoarthritis might be a similar problem in the Labrador husky as that occurring in the Antarctic. It is also suggested that these additional findings show that dietary and breeding factors are not important in the aetiology of osteoarthritis in sledge dogs.

Osteoarthritis of elbow and stifle

In the Antarctic dogs in which the elbow and stifle joints were affected, grooving of the cartilage was seen on the proximal articulatory surfaces. This grooving of a ginglymus (or hinge joint) was also found in a study of 54 Army horses over 19 years of age, where the stifle, hock and interphalangeal joints were regularly affected (Callender and Kelser, 1938). The grooving of the cartilage occurred in the direction of movement of the joint; this was also seen in the elbow joints of the Antarctic dogs.

Conclusion

In the British Antarctic Survey sledge dog, the stresses and strains involved in pulling a loaded sledge in an adverse environment are the main factors causing exaggeration of degenerative changes in the hips and shoulders, here called osteoarthritis. It is suggested that the abnormal posture of the dogs while pulling causes incorrect distribution of great pressures on

the joints, producing incorrect joint function. It is not known whether similar work-induced changes occur in other draught animals.

It therefore appears that this condition could only be noticeably alleviated by changing the way of life of the dogs and thereby eliminating their usefulness.

ACKNOWLEDGEMENTS

The authors are indebted to Professor A. T. Phillipson for facilities in the Department of Veterinary Clinical Studies, University of Cambridge, and to all other members of the staff whose advice and help was vital to a project of this nature. We particularly wish to thank Dr. A. R. Jennings and Mrs. J. R. Rest for help with pathology; Colonel J. Hickman, Mr. J. M. Hime and Professor D. D. Lawson for help and advice with interpretation of radiographs; Dr. R. A. Green for advice on the anatomy of sledge-dog movement; Messrs. Bob Martin Ltd. and the Huntingdon Research Centre for help with nutritional problems; Mr. J. E. Payne for preparing all the histological specimens; Mrs. J. Patten for preparing the illustrations; and Mr. J. Fuller for drawing Fig. 13.

The X-ray unit was loaned by the School of Veterinary Medicine, University of Cambridge, and we are most grateful to Mr. H. D. Williamson for his excellent tuition on its use for obtaining radiographs in faraway places, and to Messrs. Kodak Limited for their donation of much expensive ancillary equipment.

Dr. A. C. Palmer gave invaluable assistance with the writing of this paper. The United Kingdom staff of the British Antarctic Survey were most helpful and patient at all stages. Our greatest debt is to the men and the dogs of the British Antarctic Survey, without whose co-operation and assistance the work would not have been possible.

MS. received 18 April 1969

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APPENDIX I

SPONDYLOSIS DEFORMANS IN THE SLEDGE DOG

This disorder is characterized primarily by the presence of osteophytes on the borders of the vertebral bodies at the intervertebral spaces. Following the review by Morgan (1967) and the paper by Morgan and others (1967), we have continued to use the term spondylosis deformans. These papers showed that in England, Sweden and the United States of America the condition is more prevalent in older dogs; that the female dog showed a higher incidence than the male; and that there was a predominant occurrence of lesions at lumbar (L.)2–3, at the lumbo-sacral junction and at thoracic (T.)9–10, with an additional small peak at T.5–6. They referred to other work showing that large dogs and working breeds as a group possess a greater incidence of the condition.

In the Antarctic, while the investigation was mainly concerned with radiographic examination of the hip joints of the dogs, it was also decided to examine 11 of the older dogs by means of lateral radiographs of the spine. Two of the dogs showed no abnormality and nine showed vertebral osteophytes. The results are summarized in Table VI. From these results, fusion or ankylosis is apparent in two of the nine affected dogs.

Discussion

None of the 11 dogs that underwent lateral radiography of the spine had shown clinical symptoms that could be associated with spinal lesions. The changes found are less severe than

TABLE VI. RESULTS OF LATERAL SPINAL RADIOGRAPHY IN BRITISH ANTARCTIC SURVEY SLEDGE DOGS

Serial number (see Table IV)	*Location of vertebral osteophytes*
17	N.A.D.
18	N.A.D.
19	Small osteophytes at L.2–3
20	Very small osteophytes at T.12–13
21	Large osteophytes at L.1–2–3
22	Large osteophytes at L.1–2–3
23	Large osteophytes at T.13–L.1
25	Large osteophytes at T.13–L.1–2
27 (M; 7·8 yr.)	Ankylosis of osteophytes at L.1–2
28	Large osteophytes at L.1–2–3
29	Large osteophytes at L.1–2 and L.3–4
	Ankylosis at T.4–5 and T.5–6

N.A.D. Nothing abnormal detected.
T. Thoracic.
L. Lumbar.

those that might be seen in large dogs of similar ages in the United Kingdom, and certainly the degree of involvement is not great. The lesions occur in the areas found by Morgan and others (1967) to be predominant sites in many dogs (Fig. 14).

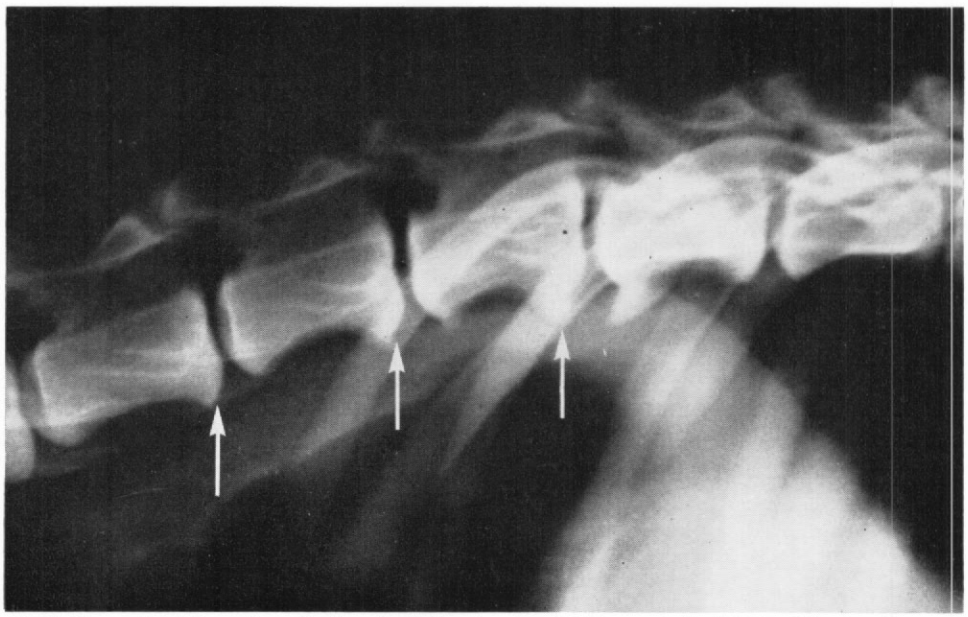

Fig. 14. Radiograph of the spine of a female sledge dog (aged 6·0 years) (Serial No. 22), showing vertebral osteophytes at the lumbar intervertebral spaces 1–2–3 (arrowed).

Morgan was able to produce spondylosis deformans experimentally by damaging the outer ring of the ventral part of annulus fibrosus, and he therefore concluded that disc lesions played a large part in the later occurrence of spondylosis. This prompted a search through the records of the Survey's sledge dogs for confirmed evidence of disc lesions. One of us (M.F.G.) found, on post-mortem examination of two males and three females, partial intervertebral disc protrusions in the lumbar region of L.1–4 and, in one male dog, complete ankylosis of the lumbar vertebrae. All of these affected animals were also found to have osteoarthritis of hip and shoulder joints. None of them had ever shown symptoms of spinal lesions.

Recently, a 5½-year-old male dog was destroyed due to signs of an apparently painful spinal lesion, and it was found on post-mortem examination to have a prolapsed cervical intervertebral disc at C.5–6. It is thus apparent that the sledge dog is not completely immune to the effects of mechanical stress on the vertebral column. However, the finding by Morgan that there was no correlation between clinical signs and the occurrence of spondylosis deformans is confirmed by our results, showing that the gait and method of pulling, via a chest harness, is less traumatic to the spine of the sledge dog than to its limb joints.

APPENDIX II

Aspects of Nutrition in British Antarctic Survey Sledge Dogs, 1960–68

Between 2 to 3 kg. of seal meat every 48 hr. has been the traditional station diet of these dogs since their introduction in 1945. After a long sledge journey during which the dogs may have lost 5 kg. of their body weight, 3 days' feeding on seal meat restores them in weight and condition most remarkably. Taylor (1957), Taylor and others (1959), Wyatt (1963) and Orr (1965), in their work on the sledging diet of sledge dogs, were primarily concerned with improving the existing dog Pemmican,* and proving that the resulting Nutrican† was not only an improvement but came nearer to the ideal sledging diet. Orr showed that the calorific value of Nutrican was 2,500 kcal./lb. (5,556 kcal./kg.) and that the average working male sledge dog requires about 5,000 kcal./day to maintain its body weight. For loading reasons, it is not practicable to feed 2 lb. (0·9 kg.)/day of Nutrican unless efficient air support is available, so a compromise level of 1½ lb. (0·7 kg.)/day is usually fed.

Thus, in quantity as opposed to quality, Nutrican would appear to be adequate. The main protein source was originally white fish meal but this was changed to whale meat solubles because of the salinity of the fish meal. At the present time, the manufacturers are having considerable difficulty in obtaining sufficient good quality whale meat and it is to be hoped that a suitable inexpensive substitute will soon be found.

The present interest in Nutrican arose from reports of a recurring skin condition in several dogs, occurring over the years 1955–67. This condition was called "ringworm" by the medical officers. In each case the affected animal lost hair in patches on the head, forelegs, chest or neck. The exposed skin showed little change, except at the borders of the patches, where there was usually erythema and oedema. This gave the appearance of a raised reddened rim to each area of hair loss. Recovery was usually spontaneous, or assisted with the use of numerous therapeutic agents including disinfectants, antibiotics and griseofulvin,‡ an antifungal agent. Cases usually occurred in the spring and had recovered before the arrival of the relieving ships. This explained why neither of the authors saw the condition, except from photographs. At the request of one of us (M.F.G.) some hair samples were taken in 1964 and a thorough examination of these samples revealed no signs of fungal infection. This confirmed the view that the history, appearance and course of the disease was unlike that of ringworm. In particular, the condition was apparently non-contagious to man or the other dogs.

From these findings, our enquiry caused us to examine the quality of Nutrican, with particular reference to the vitamin/mineral content. Although Taylor and others (1959) suggested that sledge dogs fed on Pemmican could develop thiamine (vitamin B_1) deficiency,

* Dog pemmican, Bovril Ltd.
† Nutrican, Bob Martin Limited.
‡ Fulcin Forte, I.C.I. Ltd.

no clinical evidence has confirmed this. Certainly there have been no cases of the typical Chastek paralysis that is associated with thiamine deficiency.

Taylor also found that sledge dogs excrete between 50 and 100 mg. of ascorbic acid (vitamin C) daily, of which about 90 per cent is synthesized in the body. Two of the dogs in his tests had marked palatal ulcers, showing that ascorbic acid deficiency was not responsible. However, Lacroix and others (1942) found low ascorbic acid blood levels in some dogs with non-parasitic dermatitis and these dogs generally responded to ascorbic acid therapy. In general, it would seem that sledge dogs are unlikely to suffer ascorbic acid deficiency unless there is a failure of synthesis.

From the work of Taylor and others (1959), vitamins were added to Nutrican in quantities thought to be sufficient (Table VII). In particular, it was hoped that these additions would prevent the sore gums and palatal ulcers seen in sledge dogs that had been fed on dog Pemmican for more than 6 weeks, and in this respect the diet has succeeded.

TABLE VII. MANUFACTURER'S SPECIFICATIONS FOR NUTRICAN UNTIL 1967

Constituents	(per cent)
Whale meat solubles	24
Dried debittered yeast	1
Skimmed milk powder	15
Pre-cooked maize starch	15
Beef dripping	45
Ethyl gallate	0·01
Added vitamins per 1 lb. (0·45 kg.) block	
Vitamin A	1,000 i.u.
Vitamin D	600 i.u.
Vitamin B_1	1·2 mg.
Nicotinic acid	9·0 mg.
Riboflavine (B_2)	3·0 mg.
Calcium pantothenate	2·0 mg.
Pyridoxine	0·4 mg.

Attention was paid to the vitamin content of Nutrican in 1967 following an increase in the number of reports of "ringworm" in the dogs. Photographs of an affected dog showed that the condition bore a striking resemblance to the description of riboflavin (vitamin B_2)-deficient dogs by Potter and others (1942). Amongst other more drastic symptoms of collapse and muscular weakness, these workers also described dogs showing dry flaky dermatitis of the hindlimbs, thorax and abdomen, usually with marked erythema. The deficiency was severe and death supervened before treatment could be given. Experimentally, Street and Cowgill (1939) showed that riboflavin deficiency in dogs produced sudden collapse, coma and death within a few hours. It thus appears that a marginal deficiency could cause dermatitis as seen in the Antarctic sledge dogs, but that one would also expect to see cases of collapse and death in conjunction with dermatitis, and these have not been seen.

In an attempt to prevent further occurrence of the condition seen in sledge dogs, further additions of vitamins and minerals were made to Nutrican in 1967–68 in line with canine requirements suggested by the Nutritional Research Council (Table VIII). Although this

TABLE VIII. ADDITIONS MADE TO THE SLEDGING DIET NUTRICAN IN 1967 (PER 1 lb. (0·45 kg.) BLOCK)

Ingredient	*N.R.C. requirements*	*Present in Nutrican*	*Additions in 1967*
Calcium	4·50 g.	0·87 g.	14 g. calcium hydrogen phosphate
Phosphorus	3·60 g.	0·72 g.	2·3 g. calcium tetrahydrogen diphosphate
Potassium	3·60 g.	0·90 g.	7·6 g. potassium sulphate
Magnesium	0·18 g.	0·10 g.	1·8 g. magnesium sulphate
Iron	26·0 mg.	3·0 mg.	130·0 mg. ferrous sulphate
Copper	3·0 mg.	0·2 mg.	11·8 mg. copper sulphate
Cobalt	1·0 mg.	0·02 mg.	4·75 mg. cobalt sulphate
Manganese	2·0 mg.	0·02 mg.	8·12 mg. manganous sulphate
Zinc	2·0 mg.	0·02 mg.	2·50 mg. zinc oxide
Iodine	0·6 mg.	—	1·00 mg. potassium iodate
Vitamin A	2,000 i.u.	1,000 i.u.	1,000 i.u. vitamin A
Vitamin D	120 i.u.	600 i.u.	—
Vitamin E	20 mg.	—	60 mg. vitamin E (bead form 33 per cent)
Folic acid	80 mcg.	80 mcg.	—
Vitamin B_{12}	10 mcg.	—	10 mcg.
Thiamine	0·30 mg.	1·20 mg.	—
Riboflavine	0·80 mg.	3·00 mg.	—
Pyridoxine	0·40 mg.	0·40 mg.	—
Calcium pantothenate	0·90 mg.	2·00 mg.	—
Niacin	4·0 mg.	9·00 mg.	—
Choline	500·0 mg.	110·0 mg.	—

"blunderbus" treatment is perhaps to be deprecated, no further cases have arisen after trials in the field and no dogs have shown signs of hyper-vitaminosis.

On a further cautionary note, it has long been known that small wounds on the hands can become infected by contact with seal fur, causing "seal finger". It is now known that the organism responsible is one of the ubiquitous *Erysipelothrix* group (personal communication from A. J. Rook). It is possible that the skin condition seen in the Antarctic dogs could also be caused by this organism. The symptoms seen in man are very similar to those described in the dogs. This would fit in with the occurrence of the disease, for it is seen at the end of winter when the dogs are in poor condition and are still being fed on seal meat with blubber and therefore fur attached. The organism would therefore be able to infect the dogs when they are at their lowest ebb of general health.

Finally, the manufacturers have pointed out that the sledging diet has to be made in summer in this country and, in order that it shall consist of solid blocks, it is not possible to incorporate unsaturated fats. It is therefore possible that this factor may predispose to this skin condition.

From all this theory, the fact emerges that much work needs to be done before the cause of so-called "ringworm" in the Survey's sledge dogs is known. At least, it is known that under the circumstances of manufacture and expenditure now available, Nutrican is the best sledging diet that can be devised.

APPENDIX III

Clinical Treatment of Osteoarthritis in the British Antarctic Survey's Sledge Dogs

A short-term clinical trial of drug therapy for osteoarthritis was carried out at Stonington Island in 1967–68. Dogs with serial Nos. 24 and 28 (see Table IV) were treated with phenylbutazone,* already known as an effective drug in the alleviation of arthritis, and dogs Nos. 16 and 29 were given parallel treatment with flufenamic acid,† a new preparation.

Before treatment, all four dogs were clinically affected with osteoarthritis, showing stiffness, wasting of hip and shoulder muscles, and in two cases, lameness. Dog 24 was lame on the left foreleg and was incapable of jumping up on its hindlegs. Dog 28 was markedly lame on the left foreleg, dog 16 showed overall stiffness, which diminished with light exercise, and dog 29 showed bilateral arthritis of the hips.

Both pairs were given the respective drug at the recommended dosage (300 mg. phenylbutazone, and 400 mg. flufenamic acid) daily for 3 days. On the fifth day the dogs were re-examined and were found to be greatly improved in their mobility. Dog 24 was enthusiastic about jumping up on its hindlegs for attention, dog 28 could gallop freely again, and dogs 16 and 29 showed much less discomfort when moving.

Both drugs were effective in alleviating presumed osteoarthritis. It was thought at the time that flufenamic acid had a depressive effect, as evinced by a slight fall in appetite of the dogs concerned. Further tests by the medical officer showed that a 5-day course of phenylbutazone was more successful than a 3-day course, and the effects lasted from 4 to 5 weeks. He also reported that flufenamic acid appeared to have a more vigorous effect than phenylbutazone, that a 3-day course of flufenamic acid was effective for about 2 weeks, and that this drug produced no signs at all of depression. His extended trial should be thought of as the more reliable guide.

It was recommended that these drugs should not be used on dogs in the field, since most drivers would prefer to know what their dogs are fully capable of at any particular time. For retired dogs kept at the station, the drugs may be more useful and may allow these dogs to perform useful local tasks, and also allow them to be used for breeding.

A further trial, using an anabolic steroid,‡ is being carried out in the Antarctic to see whether this can alleviate the early symptom of osteoarthritis.

* Butazolidin, Geigy.
† Arlef 100, Parke Davis.
‡ Nandrolin, Organon.