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## The Fauna and Economy of Fiaavè

The faunal collection from Fiaavè is at present the largest and most carefully collected sample of bronze age animal bones from subalpine Italy. So far only a small sample of the bones has been studied, but in view of the importance of the site and the light which it can shed on the bronze age economy of the area it seems worthwhile to make available the data as they appear from preliminary studies. I would like to record my thanks to Professor Gino Tomasi, Director of the Museo Tridentino di Scienze Naturali, and Dr Renato Perini, the excavator of the site, for making the material available to me.

Immediately apparent is the unusually good state of preservation of the material. Extensive samples of deposit were sieved for recovery of all remains and botanical specimens, and this material has yet to be studied. However, of the material recovered in the trench a very high proportion consisted of identifiable specimens. Commonly the identifiable proportion of archaeological collections is between one-sixth and one-third. As Table 1 shows, more than half of the Fiaavè sample was to some degree determinable mostly to species or genus. As no attempt was made to identify ribs or vertebrae (other than atlas and axis), which between them comprise the majority of the 'miscellaneous' category of unidentified bones, it can be seen that a yet higher proportion of the collection could be identified were the resulting information thought to justify the additional investment of time.

In spite of the relatively large number of animal species represented at Fiaavè, the overwhelming preponderance of the bones came from very few species (Table 1). Well over eighty per cent of the remains come from sheep, goat, and cattle, and it should be remembered that, because the majority of the specimens identified

only as Caprinae, large artiodactyla, and small artiodactyla must also have come from these animals, they probably account for as much as ninety per cent of the identified sample. The artiodactyla as a whole — presumptively all food animals — account for more than ninety-nine per cent of the identified sample.

Much attention has recently been given to the question of how best to calculate the probable relative importance of different animals represented in an archaeological collection. Important objections have been raised to the direct use of the relative number of identified bones

species	number	per cent
<b>Ovis/Capra</b>	2176 (256)	51.9
<b>Ovis</b>	169 (104)	
<b>Capra</b>	73 (47)	
<b>Bos taurus</b>	1400 (156)	23.5
<b>Sus scrofa</b>	317 (18)	6.5
<b>Rupicapra rupicapra</b>	9 (8)	2.2
<b>Cervus elaphus</b>	71 (5)	
<b>Capreolus capreolus</b>	22 (7)	
Caprinae	92 (6)	1.8
large Artiodactyla	125	8.8
small Artiodactyla	356	
<b>Canis familiaris</b>	9	(2)
<b>Vulpes vulpes</b>		
Canidae indet.	1	(1)
<b>Ursus arctos</b>	3	
Carnivora indet.	3	
<b>Lepus sp.</b>	1	
Anura indet.	1	0.4
Pisces	1	
Aves	2	
<b>total</b>	<b>5441</b>	<b>100.1</b>
large long bone fragments	463	
medium long bone fragments	1449	
miscellaneous fragments	3465	
<b>total fragments</b>	<b>5377</b>	

Table 1 - Species representation at Fiaavè. The figures in parentheses concern specimens tentatively referred to the taxon in question.

attributed to each animal. However, other objections apply to the other method in common use, calculation on the basis of the minimum number of individuals (see, for example, Uerpman 1973). In choosing a method much must of course depend upon the object in view. It is perhaps worth remembering that by the very nature of archaeological evidence and the distorting processes it must undergo precise knowledge of prehistoric situations must elude us, and we must content ourselves with a more general appreciation of them, however precise our observations and intricate our calculations.

It is therefore fortunate that for the purposes of palaeoeconomic studies we are concerned not with specifics, but with generalities (Higgs & Jarman, in press). What is important for our interpretation of prehistoric economies is that certain species of animal and plant were of critical economic importance; others important, but subsidiary; others unimportant; and yet others of trivial significance. This information can frequently be obtained without resorting to complex techniques. It further has the advantage of reminding us that because a particular computation yields the result that cattle represented 28.2 per cent of the collection, and pigs 14.1 per cent, we cannot consider them as in a ratio of 2:1 other than in the most general terms.

At Fiafè the crude proportions of identified specimens indicated that only caprines, cattle, and pigs were of any numerical significance. This is confirmed (Table 2) when a variety of selected anatomical elements is compared for the various animals, and this eliminates any possibility that the picture derived from Table 1 is seriously distorted by gross over- or under-representation of particular animals because of quirks in the preservation or collection of particular parts of the body. There are, of course, irregularities in the representation of the different anatomical elements, but the general picture of broad numerical relationships of the animals is constant and there is no suggestion of major distortion due to the effect of butchery practices or the vagaries of preservation.

	humerus	radius	femur	tibia	meta-podia	upper third molar	lower third molar
<b>Ovis/Capra</b>	83	201	90	195	218	82	120
<b>Bos taurus</b>	51	56	43	57	198	28	18
<b>Sus scrofa</b>	14	4	23	24	21	5	12

Table 2 - Numbers of selected anatomical elements from the main species at Fiafè. Only the medial metapodia of *Sus* have been included.

Sheep and goat are both certainly represented in the collection, and sufficient numbers of specimens permitted a distinction to be made between the two genera to give a reasonable estimate of their relative importance. A complication is introduced by the presence of chamois in the collection, and it must be admitted as a possibility that a few specimens identified as cf. *Ovis/Capra* may have come from *Rupicapra*. This is unlikely to have taken place to any significant degree however. Not only were particular pains taken to avoid this source of error, but also there are such large numbers of specimens unequivocally attributable to sheep and goat that their great predominance cannot be in doubt.

As Table 3 shows, taken as a group sheep specimens dominate those of goat by a ratio of rather more than 2:1. For all anatomical elements upon which the sheep-goat distinction was attempted sheep considerably outnumber goats, with the exception of horn cores. Whereas the ratio of sheep to goat varies from slightly greater than 2:1 to slightly greater than 6:1 on these former elements, for the horn cores the ratio is reversed, being slightly less than 1:2. Two factors are involved in this anomaly. Both sexes of goat carry horns, whereas female domestic sheep are almost invariably hornless; this provides an automatic weighting factor favouring the recovery of goat horn cores. In addition, at Fiafè there are signs that goat horn cores were specifically preserved for some industrial purpose. Nearly half of them (and virtually all of those which were complete enough to supply information on the subject) showed signs of having been deliberately cut from the skull (Plate I). Taking into account, therefore, the relative over-representation of goat horn cores it seems probable that sheep outnumbered goats at Fiafè by something of the order of 3:1 or 4:1.

There is no question that the sheep and goat populations were domestic animals, and it is of interest that there is no sign in the sample of the local wild caprine, *C. ibex*. The remainder

	humerus	metacarpal	metatarsal	astragalus	calcaneum	skull	horn core	total
<b>Ovis</b>	17	32	37	25	27	17	14	273
cf. <b>Ovis</b>	10	39	33	8	7	4	3	
<b>Capra</b>	1	11	3	10	9	4	35	119
cf. <b>Capra</b>	3	15	11	5	6	—	6	

Table 3 - Relative representation of sheep and goat at Fiafè

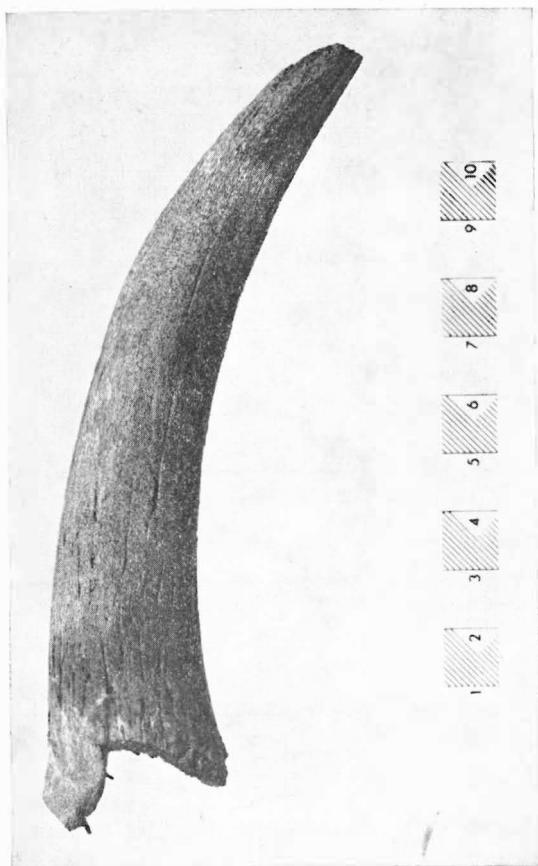


Plate I - Goat horn core from Fiavè showing traces of artificial removal from skull.

of the fauna is very similar to the modern one, consisting of the common farmyard domesticates (cattle and pig), dog, and of animals such as chamois, red and roe deer, fox, bear, and hare, which are either present locally now, or have been so in the recent past. No rodent remains at all are present in the sample so far studied, and nonmammalian remains are numerically negligible. Indeed, as was stressed above, the common domestic fauna totally dominates the collection, with sheep and goat the most common group, followed by cattle, and with pigs a minor but important element. These animals can be considered as forming the basis of the animal economy, and thus warrant a closer analysis.

**The Pigs.** The Fiavè pigs were small in body size. Table 4 indicates the size of certain anatomical elements of pigs from north Italian sites, and it can be seen that there is a distinct trend to size decrease from the Neolithic to the Bronze Age. It should be noted that this observation

holds good regardless of whether or not the large neolithic specimens are referred to a separate wild population, as is usually done. The validity and implications of such a procedure have been discussed elsewhere (Jarman 1971; in press). Here it can simply be noted that maximum, mean, and minimum dimensions of a variety of bones of bronze age pigs from northern Italy are generally smaller than their neolithic counterparts. There is some indication of a similar size decrease in the pigs of the Swiss lake villages, from a comparable ecological situation, but it seems to be less clear-cut than in the samples discussed here.

The Fiavè pigs seem to be small even compared to other available north Italian bronze age samples. Two factors may be involved in this small size; the effects of continuing long-term processes, and the immediate environment of the site. As has been shown (Jarman, in press) there are indications of a fairly steady decrease in the size of pigs from the early Neolithic of Molino Casarotto, through the late Neolithic (Rivoli) to the Bronze Age. The size of the Fiavè pigs may represent a further stage of this trend, as most of the material comes from the Middle Bronze Age, whereas the (apparently slightly larger) pigs from Monte Tondo are of Early-Middle Bronze Age in date. However, hill breeds of domestic animals are frequently smaller than their lowland counterparts, reflecting the more arduous environment and in particular low winter food levels. Fiavè, at over 600 m, is the highest of the north Italian sites whose faunal collections have been available to me, and it is likely that the site is at the edge of or beyond the natural distribution of pigs in subalpine Italy. It is quite likely therefore that environmental factors may be partly responsible for the size of the Fiavè pigs as well as for their subsidiary place in the economy, which is in contrast with their importance at other north Italian sites.

As is usual with closely controlled and intensively exploited populations of pigs a high proportion of the Fiavè pigs was slaughtered at an early age. This practice takes advantage of the high rate of reproduction of pigs which permits an unusually high crop to be extracted from the immature age groups. Table 5 shows that of the available sample of pig teeth, almost all the specimens came from animals killed in the first two years of life, with very few coming from animals of over three years in age. Similar indications came from the post-cranial skeleton. Of the bones which in modern animals fuse at about

measurement	Molino Middle range	Casarotto Neolithic mean	N	Rivoli Late Neolithic range	mean	N	Monte Tondo Bronze Age range	mean	N	Torri Bronze Age range	mean	N	Fondo Tomellero Bronze Age range	mean	N	Fiavè Bronze Age range	mean	N
upper third molar: maximum length	33.0 43.3	37.8	38	31.0 37.5	33.5	11	31.3 36.0	33.7	2	—	—	—	29.7	—	1	28.8 32.9	— 30.9	— 4
lower third molar: maximum length	35.0 48.9	40.3	40	33.2 36.8	34.9	12	32.8 38.0	35.4	2	—	—	—	29.8 36.8	33.3	2	28.8 31.7	— 30.2	— 6
distal humerus: trochlear width	32.3 40.7	37.2	26	30.6 34.1	31.8	8	—	—	—	36.9	—	1	—	—	—	26.0 28.8	— 27.8	— 3
proximal radius: maximum width	33.0 39.1	36.0	18	28.8 40.6	33.5	8	—	—	—	25.1 27.2	26.4	2	—	—	—	25.8	—	1
distal tibia: maximum width	33.9 40.2	37.6	20	30.2 43.0	33.4	9	26.2 32.9	30.8	5	—	—	—	—	—	—	25.3 28.1	— 26.5	— 3
astragalus: maximum length	41.0 55.0	49.7	15	41.5 54.0	47.5	7	39.0 53.5	44.2	3	38.1	—	1	41.5	—	1	37.0 40.5	— 38.6	— 8

Table 4 - Measurements (mm) of selected Fiavè pig bones compared with those from other North Italian sites.

twelve months, about 80 per cent were fused. Of those which fuse between twenty-four and thirty months, about 17 per cent were fused; while of those which fuse between thirty-six and fort-two months only two specimens — less than 5 per cent — were fused.

The Cattle. Like the pigs, the Fiavè cattle are relatively small in size. The same considerations apply to changes in the body size of cattle as were discussed with reference to the pigs. There is evidence in northern Italy that long-term selective pressures were operating in favour of size decrease in cattle (Table 6). Some neolithic specimens lie within the range of *Bos primigenius*, and Riedel (1948) has tentatively referred one specimen from the Fimon area to this species. There is no indication that two separate cattle populations are present at any of the sites mentioned in Table 6, however, and the size decrease cannot be referred to the elimination of large wild individuals. It seems probable that the same selective pressures involved in the size reduction of pigs from the Neolithic to the Bronze Age were also the cause of the similar phenomenon in the cattle.

Cattle mature and reproduce more slowly than pigs, and it is not economic to crop the first and second year portion of the population as heavily. It is usual therefore in a subsistence economy to crop more heavily the third and fourth year animals, when they have nearly reached their maximum potential body weight but are young enough to be palatable. At Fiavè (Table 7) according to the dental evidence the animals were slaughtered fairly regularly over

months	cumulative per cent certainly dead	cumulative per cent certainly alive
0	—	100.0
3	4.2	96.0
6	12.5	77.1
9	22.9	64.7
12	33.4	60.4
18	50.0	41.7
24	75.0	12.5
30	93.9	6.2
36	93.9	4.2
48	100.00	—
number	48	48

Table 5 - Cropping pattern of Fiavè pigs.

the first five years of life and the postcranial evidence supports this interpretation. Few individuals were certainly older than five years. A relatively high proportion of the teeth (18.7 per cent) came from individuals killed in the first six months of life. This probably represents the slaughter of young males surplus to breeding requirements and whose maintenance to an older age would have placed an undue strain upon the available winter grazing resources.

The Caprines. As we have seen the caprines, and in particular sheep, are numerically the most important animal exploited at Fiavè. The sheep are relatively small-sized, but as Table 8 shows there is no evidence of consistent size change in the neolithic to bronze age samples from the Veneto. The early neolithic sites from the area,

measurement	Molino Middle range	Casarotto Neolithic mean	N	Rivoli Late Neolithic range	mean	N	Monte Tondo Bronze Age range	mean	N	Torri Bronze Age range	mean	N	Fondo Bronze Age range	mean	N	Tomellero Bronze Age range	mean	N	Fiavè Bronze Age range	mean	N
upper third molar: maximum length	29.3 30.3	29.9	3	27.5 32.0	29.7	14	27.3	—	1	28.3	—	1	26.3	—	1	30.4	27.6	24			
lower third molar: maximum length	38.8 38.9	38.8	2	35.6 39.6	37.8	8	—	—	—	—	—	—	—	—	—	38.6	34.4	15			
proximal radius: epiphyseal width	—	—	—	70.0 89.9	76.8	11	63.3	—	1	—	—	—	—	—	—	74.8	66.5	12			
proximal metacarpal: maximum width	70.2	—	1	—	—	—	76.0	—	1	—	—	—	58.9	—	1	71.4	66.8	6			
distal metacarpal: epiphyseal width	—	—	—	56.8 66.4	61.0	5	52.5	52.0	2	43.3 46.5	44.4	2	—	—	—	57.5	51.6	14			
distal metacarpal: maximum width	—	—	—	52.0 64.5	56.7	6	—	—	—	41.2	—	1	—	—	—	50.6	45.0	5			
	—	—	—	68.7	—	1	—	—	—	48.5	—	1	56.2	—	1	57.7	51.3	3			
distal tibia: maximum width	—	—	—	57.1 68.9	63.4	15	55.5 57.5	56.5	2	48.8 57.2	51.8	3	47.2 49.6	48.4	2	51.0 61.6	56.1	7			
astragalus: maximum length	68.0	—	1	62.0 74.0	67.9	13	57.0 61.0	59.0	3	57.0 61.0	58.9	7	51.0	—	1	53.5 68.0	59.1	25			
distal metatarsal: maximum width	52.8 54.3	53.5	2	—	—	—	52.1	—	1	—	—	—	—	—	—	43.4 59.1	48.8	7			

Table 6 - Measurements (mm) of selected Fiavè cattle bones compared with those from other North Italian sites.

such as Molino Casarotto are characterised by very low percentages of caprines (Jarman, in press), but it seems from the available evidence that those, too, were small in size.

The cropping pattern (Table 9) must be taken as representing the caprine group in general, as it is not possible to distinguish consistently between the teeth of sheep and goats. However, despite the possibility of different patterns of exploitation for the two animals, certain features are likely to have been the same, such as the slaughter at an early age of males surplus to breeding requirements. This, and the fact that sheep certainly dominate the sample, probably justifies us in assuming that Table 9 gives a fairly accurate picture of the sheep cropping pattern. More than half the teeth came from individuals slaughtered in the first two years of life, few animals being slaughtered after their third year of life. There is a conspicuous peak in mortality in the second year of life when the animals would have attained a reasonable proportion of their total potential body weight.

Other Species. As has been noted the subsidiary species are present only in very small numbers. Both red and roe deer occur, and presumably represent the result of occasional hunting

or crop-protection activities. Chamois is also certainly present and was probably hunted on the high crags towards the periphery of the site exploitation territory (see below). Domestic dog is represented, as are bear and fox, probably exploited for their skins. Hare and fish are represented by one specimen apiece, while two specimens are present from a small bird. It is interesting to note the extreme rarity of fish, which seem to have been of no economic significance, despite the lakeside situation of the site.

Plant Remains. An extensive sample of plant remains was collected at the site by Mr C. Gamble, using a froth flotation unit (Jarman, Legge, & Charles 1972). The collection is still being studied, but preliminary studies by Mrs H. Jarman indicate that emmer is the commonest cereal, six-row barley also being present. A large pulse (probably *Pisum*) and a small pulse (*Vicia* or *Lathyrus*), and a large variety of fruits make up the majority of the food plants (Jarman & Gamble, in press).

Site Location and Exploitation Territory. Recent studies of prehistoric economies have led to the development of the techniques of **catchment analysis** and **territorial analysis** (Vita-Finzi & Higgs 1970, Jarman 1972). Fiavè is located on the edge

of a small lake, in an upland basin surrounded by very steep slopes and crags, which almost completely enclose the basin and rise to well over 1500 metres. The area which can be defined as readily exploitable from Fivè (within one hour's walking distance of the site) is considerably distorted by topographical factors, the steep slopes to the south and west having a particularly marked effect (Fig. 1). Today most of the territory is a mixture of alpine pasture and woodland. The woodland is primarily coniferous,

but there are some deciduous trees, particularly beech. The lower, more gentle slopes of the hills surrounding the Fivè basin in particular are under pasture, the steeper upper slopes being more heavily wooded. The floor of the basin is largely arable, with maize, hay, and other fodder plants being the primary crops. A small area of permanent pasture and marsh surrounds the residual lake. In bronze age times the pattern of land use would probably have been very similar to that of today. A higher proportion of the valley bottom would have been lake and marsh, and the heavier soils which require mechanical aids to cultivation would have been under pasture. However, as the plant remains tell us, some cultivation was certainly practised within the territory, and this must have been on the lighter and better drained of the low-lying soils. To judge from the wood employed in building the structures on the site conifers dominated the local woodland in the Bronze Age as now; and the more accessible lower slopes would have carried pasture. The upper slopes would have been largely woodland, with probably fewer clearings than today.

The Economy. The organic remains from Fivè show that both animal and plant resources were of importance, but it is difficult to assess their relative contributions to the economy. Territorial

months	cumulative per cent certainly dead	cumulative per cent certainly alive
0	—	100.0
6	18.7	80.1
12	21.5	63.4
18	31.3	53.9
24	40.6	49.2
36	58.5	34.5
48	68.1	12.5
60	90.8	9.0
72	100.0	—
number	214	232

Table 7 - Cropping pattern of Fivè cattle.

measurement	Rivoli Late Neolithic			Monte Tondo Bronze Age			Torri Bronze Age			Fivè Bronze Age		
	range	mean	N	range	mean	N	range	mean	N	range	mean	N
<b>Sheep</b>												
distal metacarpal:	21.0									21.1		
articular width	24.5	22.8	3	—	—	—	—	—	—	26.9	23.2	16
distal metatarsal:										18.5		
articular width	21.8	—	1	—	—	—	—	—	—	24.9	22.0	23
astragalus:	24.5			25.6						22.1		
lateral length	28.4	26.7	6	26.6	26.1	2	30.4	—	1	28.9	26.6	28
calcaneum:	52.0									45.4		
maximum length	53.0	52.5	2	—	—	—	—	—	—	59.0	51.4	9
<b>Goat</b>												
distal metacarpal:										24.8		
articular width	29.4	—	1	—	—	—	—	—	—	28.0	26.3	3
distal metatarsal:										22.6		
articular width	24.0	—	1	—	—	—	—	—	—	23.5	23.1	3
astragalus:				30.8						24.9		
lateral length	29.8	—	1	32.7	31.7	2	—	—	—	30.7	28.0	15
calcaneum:										55.0		
maximum length	—	—	—	57.4	—	1	63.0	—	1	59.0	55.8	4

Table 8 - Measurements (mm) of selected Fivè caprine bones compared with those from other north Italian sites.

months	cumulative per cent certainly dead	cumulative per cent certainly alive
0	—	100.0
3	5.6	93.5
6	8.9	86.1
9	12.1	80.7
12	13.9	65.9
18	40.0	46.4
24	53.3	26.0
30	61.3	18.8
36	71.1	9.7
48	84.0	4.3
60	96.4	3.3
72	97.0	—
84	97.2	—
96	100.0	—
number	686	690

Table 9 - Cropping pattern of Fiaù caprines.

analysis is of assistance in this situation, as it offers an independent line of argument in the light of which the evidence from organic remains can be considered. Territorial analysis can indicate what the most advantageous economic policy would have been, and it can be assumed that in the long term human populations will tend towards the most advantageous economy possible within the prevailing conditions of technology and resources (Higgs & Jarman, in press).

Under modern conditions the economy of the area is concerned almost exclusively with the exploitation of cattle and with forestry. As far as the local population is concerned the cattle are by far the more important, as the forestry is a state enterprise. Today even the arable element in the economy is geared to pastoral requirements, for the maize is grown as cattle fodder, the other arable crops also being fodder plants. The modern situation depends on a technology and transport system such that the area does not have to be self-sufficient; most food staples are imported, the cattle producing dairy products for export. In the past Fiaù must have been a subsistence settlement, self-supporting within its annual territory (that area exploited by a human group in the course of a year (Vita-Finzi & Higgs 1970)). The carbohydrate requirements of the community must have been supplied from within this territory. Given the nature of cereal products, and the labour which would have been involved in their long-distance transport, it seems almost certain that the cereals found at Fiaù

would have been grown within the site territory. As will be seen below, there are reasons for suggesting that the annual territory of the Fiaù population was approximately the same as the site exploitation territory, with the probable addition of adjacent alpine pastures.

The plant remains recovered at the site indicate that a developed and well-adapted system of agriculture was being practised. Emmer probably provided the human cereal staple, and as we have seen this was the commonest of the cereals at the site. The use of emmer is significant when the geographical situation of the site is considered. At over 600 metres, the area is characterised by high rainfall (well over 1000 mm per annum), about 55 per cent of which falls between April and September. Low winter temperatures constitute a further obstacle to successful cereal farming. Emmer is one of the most adaptable wheats, and in particular can be counted upon to give reasonable yields in situations where other cereals would fail altogether. A catalogue of its virtues can be found in Carleton (1901), but here it is of particular interest to note that among its qualities are winter hardiness, resistance to fungoid diseases (brought on by wet growing conditions), ability to withstand damage during a wet harvest and adaptation to a short growing season. All these factors make emmer an especially well adapted crop for the Fiaù area. The pulses and barley must have been grown in rotation with the emmer, the barley and at least the smaller pulse (if it proves to have been cultivated) probably being used as animal fodder.

Clearly, then, there was a significant arable component in the economy. There are reasons for believing that it was the minor element, however, quite apart from the climatic and geomorphological limitations to cultivation. The area of potentially arable land within the exploitation territory was about 17.5 per cent, the remainder being pasture and woodland (c. 79.5 per cent) and lake with water-meadows (c. 3.0 per cent). The proportion of potentially arable is almost precisely that under cultivation today in the Giudicarie Esteriore area as a whole (17.54 per cent). (This figure is taken from the Carta Forestale del Trentino, compiled by the Camera di Commercio Industria Artigianato e Agricoltura, Trento.) Were arable resources a prime reason for occupying the site a more central location within the basin would have increased the proportion of potentially arable land within the territory. More specifically, the location of the site

places lake and marsh between the site and the only available arable soils. For this reason virtually no arable soils are accessible within ten minutes of the site, a time threshold which has been found of great importance as a limiting factor for agricultural activities (Vita-Finzi & Higgs 1970, Jarman 1972). Were the site located on the northeast margin of the lake rather than the southwest, a larger arable component in the economy could be argued. As it is, although we have certain evidence for agriculture at the site, it seems reasonable to suggest that the pastoral aspect of the economy was dominant, then as now.

A notable difference between the bronze age and the modern economy is the total absence of sheep from the area today, as compared with their great importance in the Bronze Age. One reason for the modern absence of sheep is the legal prohibition on their being pastured in the area, presumably in the interests of forestry protection. In an effort to develop the forestry resources the areas in which sheep are permitted are closely restricted throughout the alpine zone. Also of importance has been the development of food concentrates for cattle. These permit more cattle to be over-wintered today than formerly, as this number was in the past severely limited by the availability of winter fodder. It should not be forgotten of course, that the economic value of the cattle and sheep is far from equal. In spite of the fact that there were approximately twice as many caprines as cattle in the bone sample, the cattle must have been by a considerable margin the more important in the economy, for we must take into account not only the considerably greater body weight (and meat yield) of cattle, but also their infinitely greater milk yield. Milk products are the main objective of the modern cattle husbandry of the area, and there seems every reason to suppose that they were an important resource in bronze age times. Although it is not possible to propose a precise relative value for cattle and sheep, it is worth remembering that a common standard in mediaeval Europe was one cow to ten sheep.

In order to understand fully the nature of the economy practised at Fiafè it is necessary to ascertain whether the site was seasonally or permanently occupied, and what relationship the site exploitation territory bears to the annual territory. Considerable falls of winter snow today — and presumably in the past — mean that winter occupation is only possible at the expense of overcoming the difficulties and limitations

which the weather conditions impose. This might suggest that Fiafè was occupied during the summer only, or at least was not occupied in mid-winter, the climatic limitations being overcome by a move to the lowlands. There is considerable evidence against this hypothesis, however. Each of the three primary animals exploited gives evidence of having been cropped at the site throughout the year. This is particularly well demonstrated by the caprines (Table 9), and while in the very nature of the evidence it is not possible to prove beyond question a permanent occupation, the dental evidence is strongly against the hypothesis of an absence for any prolonged period. It seems likely that in the Bronze Age, as today, some of the stock left the village to exploit the high pastures during the summer, with much of the cattle population however remaining within the site territory. The large number of cattle slaughtered as calves and yearlings may reasonably be interpreted as a response to the high degree of pressure on winter fodder resources.

Thus in the Bronze Age the cattle and sheep would have been grazed as far away from the site as was possible during the summer (the sheep probably on high alpine pastures, the cattle nearer the site, towards the edge of the exploitation territory). As much as possible of the pastures adjacent to the site would have been conserved for winter use as hay or faggage. The importance of the lake and surrounding marshland is here highlighted. It is observed today that winter snow lies less thickly immediately around the lake than elsewhere in the basin, or indeed not at all. This would be of obvious assistance in the problem of over-wintering as many cattle as possible. Similarly, in areas suffering cold winters with total cessation of plant growth, it is notable that marsh areas tend to carry the first flush of spring grass, thus affording a vital resource to pastoralists at the end of the lean season of the year. It was suggested earlier that emmer provided the human carbohydrate needs. It is probable that any surplus was used for cattle fodder. In America it was found that emmer 'is readily eaten by all kinds of stock, and has shown itself to be especially adapted when fed to milch cows' (quoted in Carleton 1901). In addition to the barley and pulses, a further autumn and winter fodder resource would have been the emmer straw, which was found to be especially palatable to stock.

If the argument is accepted that Fiafè (and presumably similar sites such as Ledro) was



permanently occupied, we are justified in inferring that by the Bronze Age northern Italy as a whole was being subjected to considerable population pressure. The distance between Fiaavè and the nearest available lowland grazing areas (a small patch to the north of Lago di Garda, but more particularly the northern fringe of the Po plain) is not great, and is of a similar order to that travelled yearly by transhumant pastoralists in many parts of Europe (including Italy) to this day. The distance involved is not therefore likely to have impeded the growth of such a system. Had sufficient areas of lowland winter grazing been available more stock could have been carried in the Fiaavè area than was possible with shortage of winter fodder constituting such a severe limiting factor in that area. Here as in many other areas of Europe, there is a large surplus of summer grazing resources which cannot be fully exploited for lack of winter grazing. Thus we are led to the view that Fiaavè was permanently occupied because the lowland areas were already fully exploited and could not accommodate an additional winter influx.

From this point of view we may consider the very existence of such sites as Fiaavè as illustrating the population pressure which caused occupation on a permanent basis of areas which in earlier periods were probably only exploited on an occasional or mobile basis. Here the significance of the arable part of the economy may be seen in a new light, as it seems quite possible that the role of the cereals was to make permanent settlement possible in an area where it would not be so with an exclusively animal-

based economy. The importance of the cereals, partly for human consumption, but maybe even more vitally as animal fodder allowing them to survive the winter, may thus greatly exceed their relative calorific contribution to the diet. Here, too, we must note the importance of technological advances, which permitted the cultivation of soils which would have been impossible or uneconomic to till with a neolithic technology. The recent find of an ard at Fiaavè illustrates that use was being made of such advances.

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