— 6 —

Early Domestic Animals in Europe: Imported or Locally Domesticated?

◆

Peter Rowley-Conwy

This chapter considers the evidence for early domestic animals in Europe, specifically the evidence for the local domestication of native cattle and pig, and for the pre-Neolithic introduction of domesticates.[1] I argue that there is little good evidence for either of these. In most cases the domestic animals were apparently imported as a group at the start of the Neolithic, although there are exceptions. The belief that some Mesolithic peoples domesticated animals derives from the assumption that these societies were going through a unilinear development identical to that of the Near East—only a few thousand years "later." I see no justification for this assumption. In addition, the idea that the Mesolithic developed to the point where it began domesticating animals just before the Near Eastern package arrived seems a great coincidence. Such vitalist or progressivist perspectives are thus open to question. Although I argue for a fairly abrupt introduction of domestic animals in any particular area, it should be noted that this does not have any bearing on whether the people were immigrants or not.

Sheep And Goats

It is now virtually universally agreed that there were no native sheep or goats in Holocene Europe (Poplin 1979; Vigne 1988, 174–89). This has been demonstrated metrically for sheep in the western Mediterranean (Uerpmann 1987). Near Eastern sites are characterized by many small animals (inter-

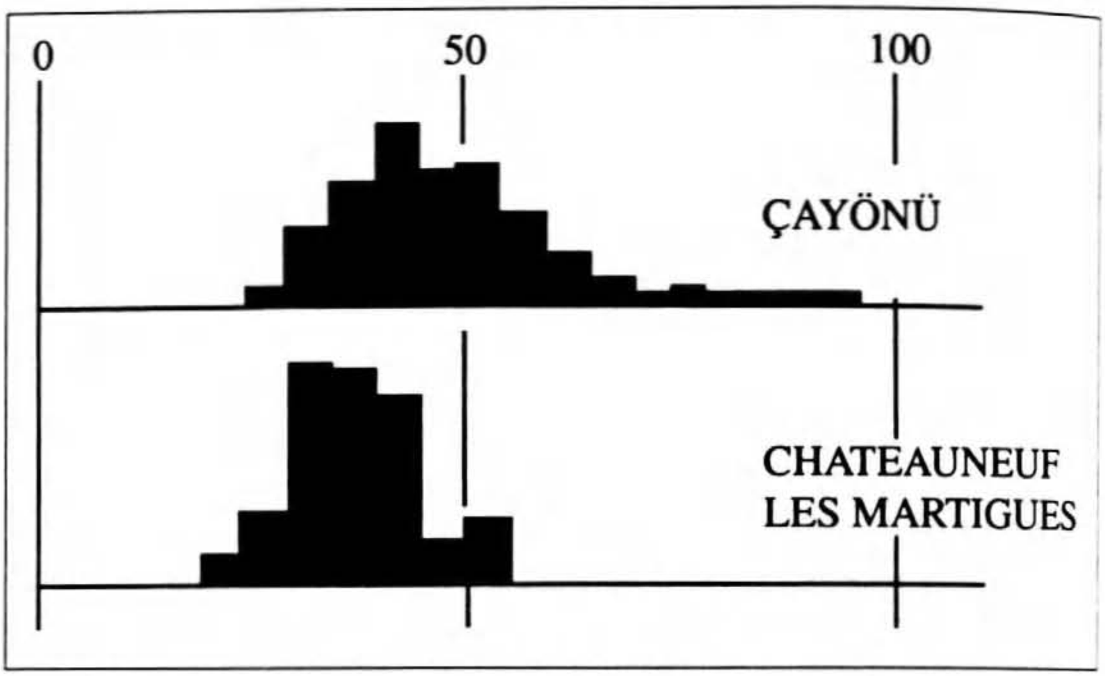

Fig. 6.1. Distribution of sheep measurements at Çayönü (Turkey) and Chateauneuf-les-Martigues (southern France). (Redrawn from Uerpmann 1987, fig. 1)

preted as domestic) and a few large animals (interpreted as hunted wild individuals). In figure 6.1, Çayönü has a typical distribution of this kind with a "tail" of large individuals projecting to the right; it does not form a normal distribution as would be expected if a single biological population was represented. Individuals from two genetically distinct populations must be present, and these must be wild and domestic—even though not every specimen can be diagnosed. Chateauneuf-les-Martigues differs in having no large wild individuals, only the smaller domestic ones forming a more or less normal distribution. The absence of hunted wild individuals indicates that there were no Holocene wild populations in this area.

Further east, claims for both wild and domestic sheep in the Mesolithic at La Adam in Romania are not paralleled at other sites in the region, and are likely to result from stratigraphic problems (Bökönyi 1977). It currently looks as if neither wild sheep nor wild goats were present in early Holocene Europe.

Claims have been advanced that domestic sheep/goat were introduced into the final Mesolithic ahead of the appearance of the formal Neolithic. But these claims remain problematic. For example, the site of Deby in Poland yielded 29 fragments identified as terminal Mesolithic sheep/goat. But there is radiocarbon evidence of later contamination (Lasota-Moskalewska 1998); the bones themselves have not been directly dated. The western Mediterranean is the area where terminal Mesolithic sheep/goat are most often claimed (e.g., Ducos 1977; Geddes 1985). Some doubt has recently been cast on these claims for two main reasons. First, caves are notoriously complex archaeological sites: deposits frequently are disturbed by burrowing animals and later human activity. And there is considerable evidence of this at the relevant sites (Zilhão 1993). Renewed excavations at Chateauneuf failed to find sheep in the Mesolithic layers (Courtin et al. 1985). Secondly, the presence of wild chamois and ibex in the region are a complicating factor: their bones can be very similar to those of domestic caprines, particularly if fragmented and/or juvenile (Uerpmann 1987). In the recent publication of the important site of Dourgne, Guilaine considers both problems and is very cautious about possible pre-Neolithic caprines (Guilaine 1993, 452–8). At Arene Candide in Liguria, sheep were present from the start of the Neolithic; goats were apparently absent until the start of the middle Neolithic (Rowley-Conwy 1997, 1998, 2000a). As the western Mediterranean Neolithic appears to have spread along the coast, this indicates that even early Neolithic claims of domestic goats further to the west may have to be reexamined.

Cattle

Research on cattle is more complex because of the presence of wild aurochs (*Bos primigenius*) throughout Europe. The possibility that animals were locally domesticated therefore exists, and the proposal has been advanced in several regions. Some of these regions are in areas of little zooarchaeological research and few comparative samples, such as southeastern Italy (Cipolloni-Sampò 1987). This review will therefore concentrate on two claims in better-researched areas of Europe: Hungary and southern Scandinavia. In Hungary, the claims involve Neolithic farmers seeking to increase their holdings of domestic cattle by domesticating more from the wild. In southern Scandinavia, the claimed domesticates appear in late Mesolithic contexts.

The Hungarian case will be considered first. Bökönyi argued for local domestication of aurochs. He believed that the first domestic cattle were introduced from elsewhere in the early Neolithic, but that these were supplemented by a much larger number of local domesticates in the middle and later Neolithic. He advances four proofs of local domestication: first, the presence of both wild and domestic forms on archaeological sites; second, the presence of forms transitional between wild and domestic; third, a change in the age and sex of the wild animals killed; and fourth, implements or buildings designed to capture the wild form (Bökönyi 1974, 111).

Of these four, the first would also be the result if domesticates were introduced and wild animals continued to be hunted, while the fourth may be discounted as no such evidence would ever be unambiguous. In support of the third, Bökönyi (1974, 112) states that at the site of Berettyószentmárton, "a typical settlement of the domestication fever of the late Neolithic where the domestication of cattle was one of the most important parts of animal husbandry," most of the wild cattle were adult males. In order to domesticate the young animals, these protective males would first have to be killed; their presence is thus evidence that domestication was taking place. This reasoning is, however, unlikely to be correct, since adult male aurochs would probably have lived apart from the females for much of the year, joining them for the mating season. We cannot be sure how aurochs would have organized their social lives, but the pattern of some males living apart for part of the year recurs in their closest surviving relatives. It is reported among semi-feral cattle (Ewer 1968, 89), bison in both Europe and North America (Fuller 1960; Jaczewski 1958), and to an extent African buffalo (Sinclair 1974). Protective females would be more likely to pose a threat to anyone seeking to interfere with their calves, so the bones of wild adult males on a settlement can hardly be taken as evidence that young were being domesticated.

Bökönyi's second criterion, animals transitional between wild and domestic, is therefore the crucial one—yet it is questionable whether Bökönyi's methods allowed him to distinguish even between wild and domestic, male and female, far less between these and "transitional" animals. The only example he gives is one that compares proximal metacarpals from Seeberg Burgäschisee-Sud (originally published by Boessneck et al. 1963) with those from Berettyószentmárton (Bökönyi 1974, table 1). The measurements are plotted in figure 6.2. At Seeberg, wild and domestic animals were identified (Boessneck et al. 1963), falling into clearly separate size groups. At Berettyószentmárton, however, the two categories run together, which Bökönyi regards as evidence for transitional animals.

There are two problems with this conclusion. First, the proximal metacarpal is a bad bone to use. The epiphysis is fused at birth so there is no direct indication of age if the bone is broken and the distal end (which does fuse) is missing. The presence of subadults may thus be a complicating

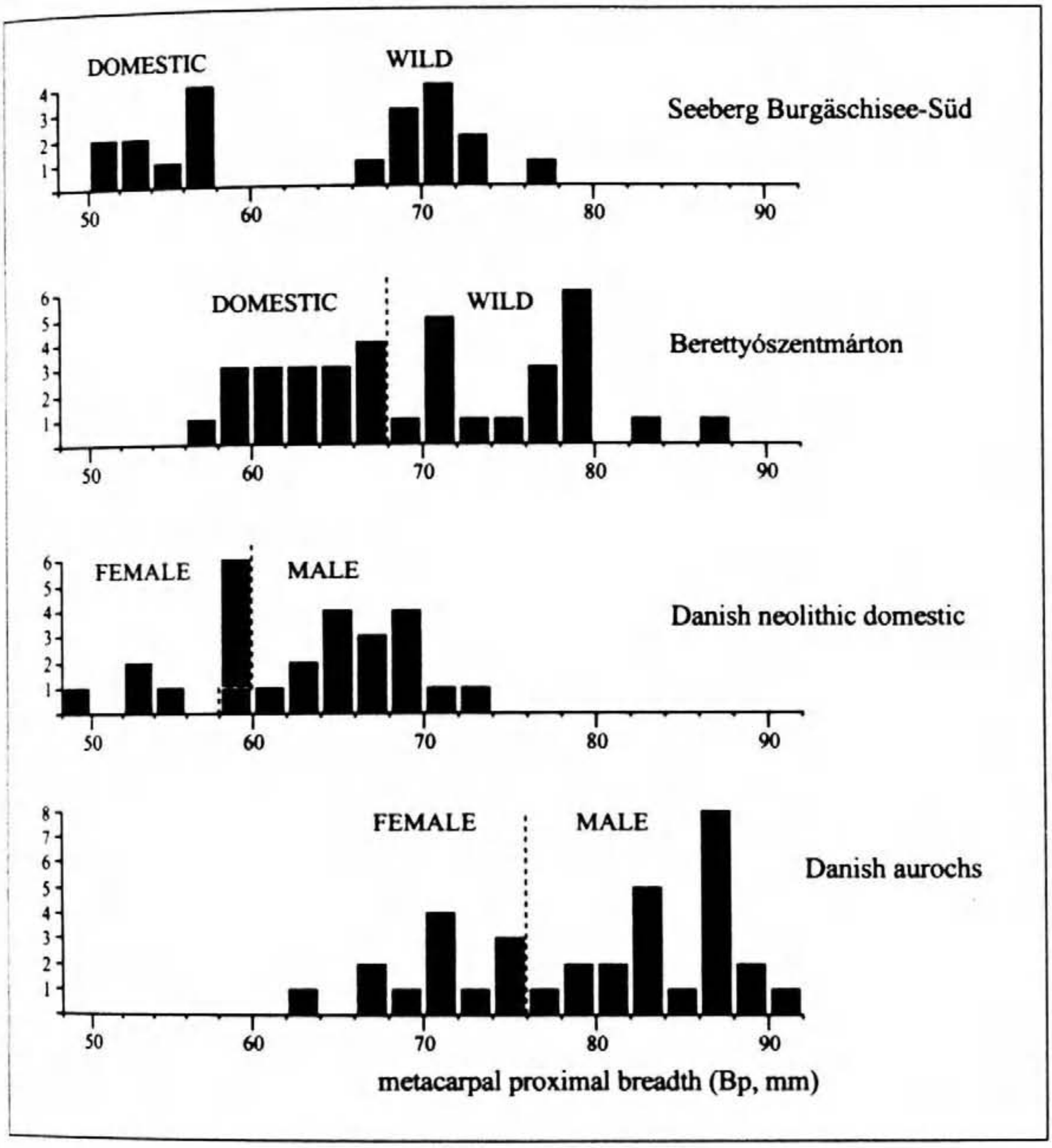

Fig. 6.2. Breadth of cattle proximal metacarpals (measurement Bp as defined by von den Driesch 1976). Seeberg Burgäschisee-Süd from Boessneck et al. (1963, 183–5); Berettyószentmárton from Bökönyi (1974, table 1); the Danish Neolithic domestic sample comprises those listed by Degerbøl and Fredskild (1970, table 11) and the complete bones from Troldebjerg listed by Higham and Message (1968, table C); Danish aurochs from Degerbøl and Fredskild (1970, table 11).

factor. Secondly, Bökönyi takes no account of sexual dimorphism. Work on naturally occurring aurochs skeletons from Denmark has demonstrated that males are larger than females (Degerbøl and Fredskild 1970); the sex of these specimens can be determined from their associated horn cores, which is not possible with fragmentary and dispersed material from archaeological settlements. The aurochs measurements are plotted in figure 6.2. Also plotted are the measurements from Neolithic animals of known sex; these are either from partially complete skeletons that may be sexed by their horns (Degerbøl and Fredskild 1970) or are unbroken bones from the site of Troldebjerg that may be ascribed to sex on the basis of their length—males being longer than females (Higham and Message 1968). The sexual divisions for both Danish aurochs and Neolithic domestic cattle in figure 6.2 are thus likely to be reliable and are not based just on drawing a line through the approximate center of the distributions. It is clear from figure 6.2 that the distributions of both Danish samples are very similar to that from Berettyószentmárton, which therefore probably comprises just a single population—presumably domestic, though one or two hunted aurochs cannot be excluded. Little justification can be found for dividing the Hungarian sample into wild and domestic, and none for assuming the pattern indicates local domestication. It is not clear why the Seeberg pattern is so dichotomous; this assemblage was published before Degerbøl and Higham demonstrated the degree of sexual dimorphism to be found in cattle. It should perhaps be reexamined in the light of more recent findings.

The distal end of the metacarpal is altogether more useful, because all fused specimens must come from animals older than about two years of age. Bökönyi curiously does not give the measurements from Berettyószentmárton, but lists a few Neolithic specimens from other sites (Bökönyi 1974, 461). The sample is, however, too small and scattered to offer much support for any argument. Figure 6.3 plots these and various other samples. Those from Seeberg fall into two distinct groups, once again identified as wild and domestic (Boessneck et al. 1963). The Danish aurochs in figure 6.3 are also bimodal, as are the Neolithic specimens. This definitely results from sexual dimorphism; once again this raises doubts about the Seeberg sample. In the absence of sufficient published data, the Hungarian situation cannot be discussed further.

The conclusion for Hungary is thus that there is no support for the hypothesis of local domestication. This is by no means the first time that objections have been raised (e.g., Bogucki 1989). It seems to be most unlikely that middle and late Neolithic farmers requiring more domestic cattle would choose the domestication of more wild individuals as the means to achieve this. Why not simply breed from the existing domestic stock? It is even more implausible that such new domesticates would then be kept genetically separate from the preexisting domesticates—which they would have to be for Bökönyi to be able to recognize them. First generation domes-

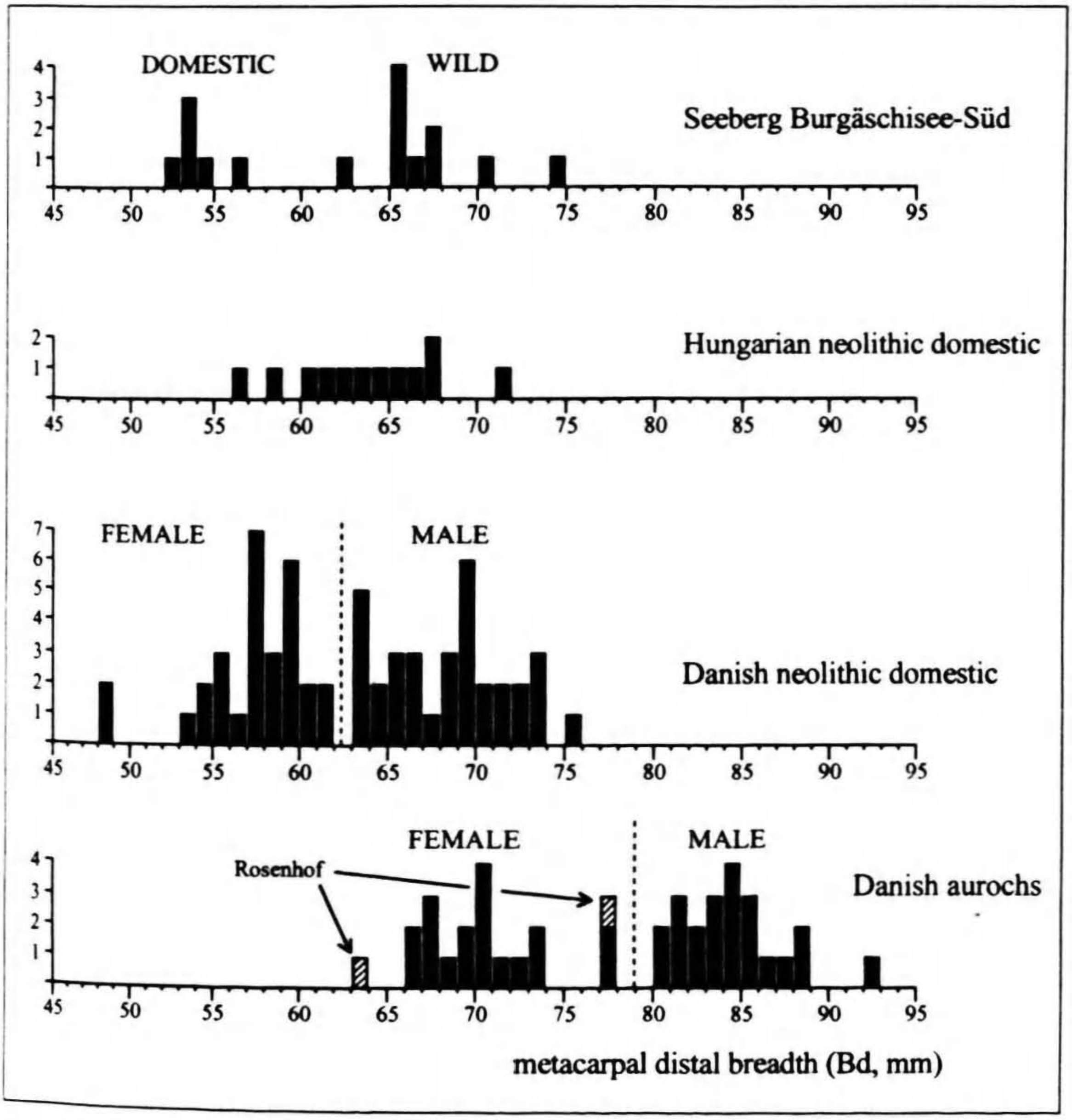

Fig. 6.3. Breadth of cattle distal metacarpals (measurement Bd as defined by von den Driesch 1976). Seeberg Burgäschisee-Süd from Boessneck et al. (1963, 183–5); Hungarian sample from Bökönyi (1974, 461); the Danish Neolithic domestic sample comprises those listed by Degerbøl and Fredskild (1970, table 11) plus all the distal ends from Troldebjerg plotted by Higham and Message (1968, fig. 43); Danish aurochs from Degerbøl and Fredskild (1970, table 11).

ticates would not of course show any size change, so this separation would have to be maintained for many generations for the effects to become visible. Bökönyi's scenario is therefore most implausible, and not supported by the data he presents.

In Denmark and northern Germany, a few domestic cattle have been claimed in late Mesolithic contexts. Farming was present not far to the south, so such cattle (or their meat) could certainly have been imported from the farmers. The claims are, however, based on metrical evidence, which is in no case unequivocal. The naturally occurring aurochs skeletons mentioned above have led most to reject the claimed domesticates in Denmark.

Four lower third molars from Dyrholm I were initially thought to be so small that they must be domestic (Degerbøl 1942, 1963). More finds of skeletons, however, extended the aurochs' size range downward, and better dating indicated that many of the smaller specimens fell later in time, contemporary with the late Mesolithic (Ertebølle) in the late Atlantic period. This led Degerbøl to reconsider his position; in 1970 he concluded that all four Dyrholm I specimens were probably wild (Degerbøl and Fredskild 1970), a conclusion that has gone largely unchallenged within Denmark. One tooth from Rosenhof in northern Germany has more recently been claimed as domestic by Nobis (1975, 1983; Heinrich 1993, 84; Persson 1999, 47–8). But it falls very close to the four from Dyrholm I, and Degerbøl's argument applies equally well: the Rosenhof tooth is insufficiently far removed from the aurochs' size range to be accepted as definitely domestic (see Rowley-Conwy 1995).

For other bones in the skeleton, Degerbøl demonstrates that domestic males and wild females are similar in size (figs. 6.2–6.3). A bone sample containing both wild and domestic animals should thus contain three size groups: (1) the very large wild males, (2) the small domestic females, and (3) the intermediate group of both wild females and domestic males. Degerbøl's conclusion is straightforward: since wild males are commonly found on late Mesolithic settlements, but domestic females never are, it is logical to conclude that the intermediate size group represents only wild females and not domestic males. Given the considerable size difference between wild and domestic cattle, it is most likely that the domestic ones were introduced (Degerbøl and Fredskild 1970, 134). Two distal metacarpals from Rosenhof in northern Germany are plotted in figure 6.3; the smaller has been claimed as definitely domestic, the larger as falling in the "wild-domestic-transitional-field" (*Ur-Hausrind-Übergangsfeld*; Nobis 1975). Degerbøl's argument continues to apply, however, and it is likely that both specimens are from wild females (Rowley-Conwy 1995). The unlikelihood of anyone keeping very small numbers of wild and transitional cattle in two separate genetic stocks is reiterated.

There is therefore no good evidence for domestic cattle in the Danish late Mesolithic, though direct dates on some specimens are needed. The earliest published bones from Denmark likely to come from domestic cattle are those from Åkonge, where 16 fragments appear alongside very large numbers of red deer and wild boar. The site is ^{14}C dated to ca. 3000 B.C. (uncalibrated)—right at the transition to the Neolithic (Gotfredsen 1998). It is important that the bones themselves be directly dated, but their domestic status is supported both metrically (Gotfredsen 1998, fig. 3) and by the fact that Åkonge lies on the island of Zealand, on which aurochs had long been extinct (Aaris-Sørensen 1980). The cattle must therefore have been introduced. In northern Germany, two late Mesolithic scapulae are claimed to come from domestic animals, one from Rosenhof and one from Bregendtwedt-Förstermoor at Satrup (Nobis 1962, 1975). This is, however, based on collum length (the width of the "neck," measurement SLC according to von den Driesch 1976), an even less reliable element than the proximal metacarpals from Hungary. It is highly age dependent: for example, in female red deer, it increases by 50% after fusion (Legge and Rowley-Conwy 1988).

Pigs

As with cattle, wild pigs are present throughout Europe. This has often caused problems for separating wild from domestic. But the arguments have been more complex than for cattle: some authorities, having failed to demonstrate whether the animals were wild or domestic, have gone on to question whether the distinction between wild and domestic is at all meaningful. In other words, osteological uncertainty is assumed to mean behavioral intermediacy—not necessarily a valid extrapolation.

A good example comes from the work of Jarman (1976, 528), considering the pigs from the north Italian Neolithic site of Molino Casarotto. He states (528) that the Molino Casarotto pigs "bridge the accepted size ranges of wild pigs and Neolithic domestic pigs from sites such as Seeberg Burgäschisee-Süd. Furthermore, there is no indication that we are dealing with two separate populations of pigs as regards size, as no strongly bi-modal tendency is apparent in the size distribution of the bones." The difficulty of classifying as clearly "wild" or "domestic" such practices as Medieval pannage (driving pigs into woodland to feed on acorns) or some New Guinea pig husbandry is then often invoked in support of the "intermediate" behavioral interpretation (Jarman and Wilkinson 1972).

This argumentation is questionable. First, the comparison between Seeberg Burgäschisee-Süd and Molino Casarotto is dubious. Lower M3 length (the only measurement actually listed by Jarman for Molino Casarotto) is plotted in figure 6.4. Many specimens at Molino Casarotto are indeed smaller than the wild boar at Seeberg—but Molino Casarotto is to the south of the Alps, while Seeberg is to the north. The mountains separate two wild boar populations occupying different climatic and vegetational zones. Like many other animals, wild boars diminish in size as temperatures increase (for archaeological examples, see Davis 1981; Rowley-Conwy 1995). Animals at the two sites would therefore be expected to differ in size. Seeberg is therefore not an appropriate comparison.

But does the absence of visible bimodality at Molino Casarotto indicate that there was a single pig population living in some "intermediate" manner? This is doubtful; one may ask, how does an "intermediate" pig actually live? Most exploitation practices can in fact be categorized as "wild" or "domestic" fairly easily. Medieval pannage was carefully regulated, and the pigs were in no sense "feral" or "semi-wild." In medieval Welsh laws, "Pannage . . . was reserved for the animals of authorized persons during a defined season in autumn and early winter. . . . These woods were guarded, and the entry of

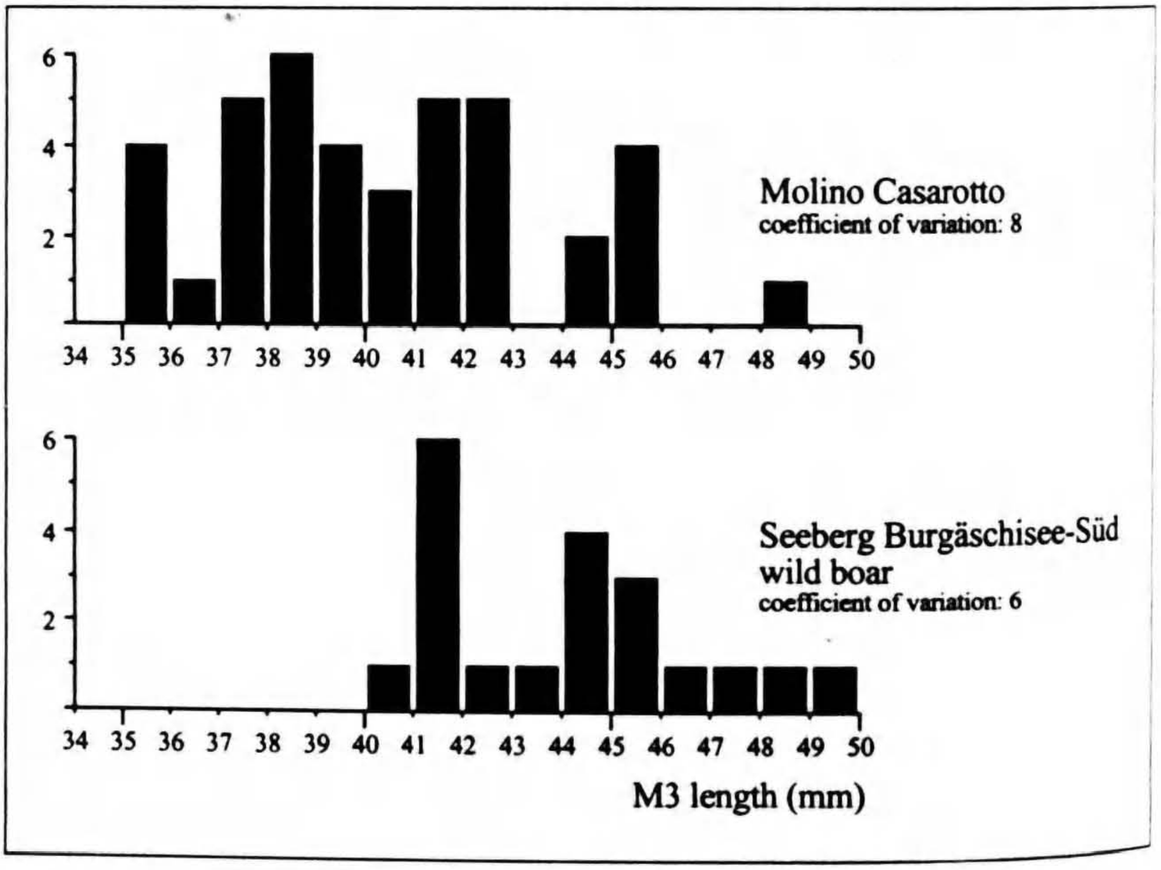

Fig. 6.4. Lengths of lower third molars of pigs. Molino Casarotto from Jarman (1976, table 4); Seeberg Burgäschisee-Süd from Boessneck et al. (1963, table 8).

unauthorized swine during this close season was an act of trespass to be compensated for or punished as such" (Linnard 1982, 16). Pigs at pannage were accompanied by swineherds (Edlin 1970, 97); the Medieval *Luttrell Psalter* contains an illustration of a swineherd up an oak tree shaking acorns onto the ground for his pigs to consume (the relevant illustration is folio 59, verso). There is no difficulty in regarding such pigs as fully domestic, even though they did not live in a field like sheep. Most practices in New Guinea, such as those listed by Rosman and Rubel (1989), are also classifiable. The "intermediate" situations involve female pigs roaming freely in and around a village, and breeding with feral boars encountered outside the village. Among the Etoro, litters of piglets are brought into the longhouses. "The piglets are subsequently fed and fondled for three to six months so that they will develop a permanent attachment to their owners. . . . Each piglet is individually named, its ears are clipped to make it readily distinguishable from wild pigs (which are hunted), and the males are castrated." As they get older they wander more widely, but are "frequently encountered in the course of daily activities. On these occasions a pig is invariably called by name, stroked, scratched, and fed bits of food in order to renew its familiarity with it. Any pig, whether recently reared or mature, will be sought out by its owner to receive such ministrations if it has not been sighted by some member of the community for more than a week" (Kelly 1988, 115–6). Why should pigs like this not be considered fully domestic? The crucial point is that by breeding with wild males, there is no genetic distinction between wild and domestic. A bone assemblage from an Etoro village would thus have the characteristics of a single population, although it comprises both wild and domestic individuals.

In prehistoric Europe, any pig assemblage that has the characteristics of a single population could thus be fully domestic, fully wild, or represent an Etoro-like situation where domestic females breed with wild males. A single-population assemblage is thus quite difficult to interpret. For Molino Casarotto, Jarman gives no reason for choosing any one of these in preference to another. But has Jarman demonstrated that only one population is present at Molino Casarotto?

A significant development in the study of pig populations has been the work of Payne and Bull (1988), in which the metrical parameters of a single population are established. For any given measurement (e.g., lower M3 length), the mean and standard deviation are calculated. Pearson's coefficient of variation (the standard deviation as a percentage of the mean) is a measure

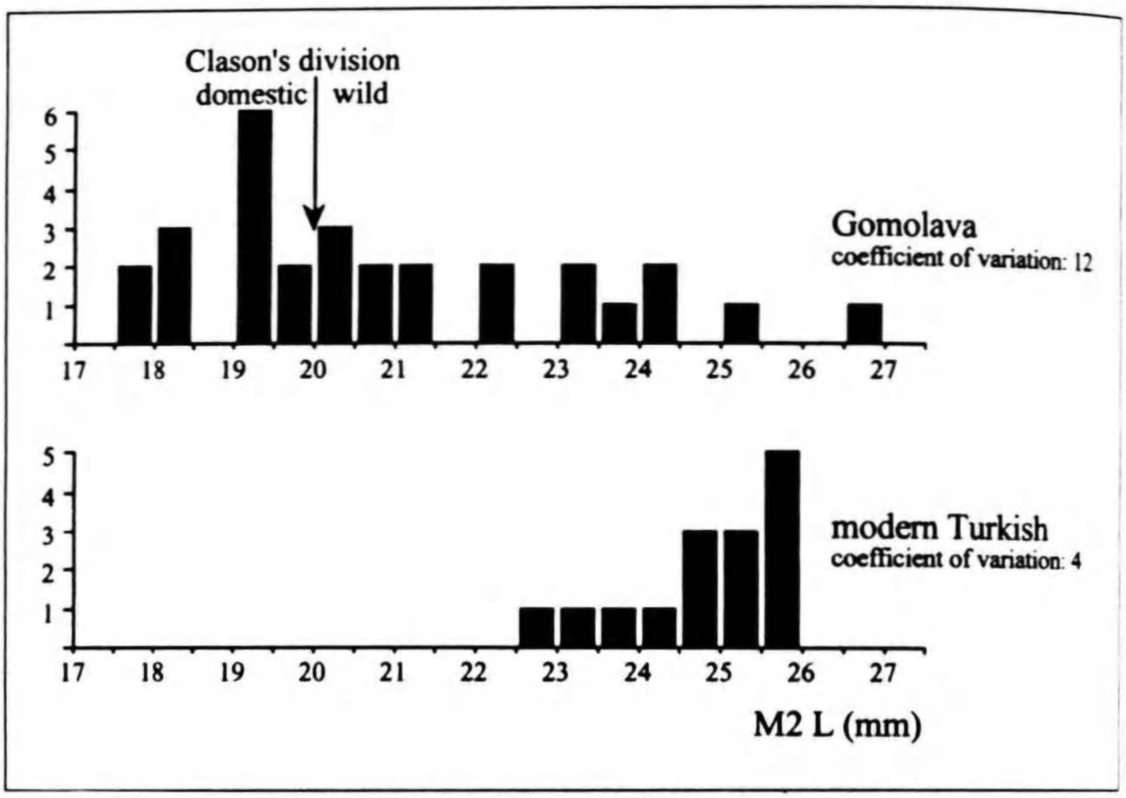

Fig. 6.5. Lengths of lower second molars of pigs. Gomolava from Clason (1979, table 6); modern Turkish from Payne and Bull (1988, table 1a).

of the spread of the measurements independent of the absolute size of the individuals. Figure 6.5 presents an example, based on M2 because insufficient M3s were available to Payne and Bull. The modern Turkish distribution is visibly tight and unimodal, and it has a coefficient of variation of 4. The Neolithic site of Gomolava in Yugoslavia was examined by Clason (1979), who believed that both wild and domestic pigs were present (fig. 6.5). The Gomolava spread is wide; Payne and Bull applied their method to these measurements, and a coefficient of variation of 12 was obtained. This must mean that two genetically separate populations of different sizes are represented. If all pigs were part of a single gene pool, the spread would be similar to the modern Turkish sample. The only way that two separate populations could exist is if one were wild, the other domestic. The domestic animals must have been under close human control. If any significant number of illicit liaisons in the undergrowth had occurred between wild boar and domestic females, the size difference between the two populations would disappear. This conclusion of Payne and Bull's thus supports Clason's contention that both wild and domestic pigs were present—even though the Gomolava sample is not bimodal, and whether or not Clason's actual point of division is correct.

Payne and Bull's method is a useful tool for examining assemblages. On occasion, interpretation becomes difficult if only few wild individuals are hunted because the coefficient of variation does not depart very far from that expected in one population (Rowley-Conwy 2000b). This may be the case at Molino Casarotto, where the coefficient for M3 length is 8—only a little larger than expected for a single population (cf. the value of 6 for Seeberg). More data might resolve this. But the Molino Casarotto sample in figure 6.4 shares one typical feature with many other assemblages: a major peak of smaller individuals and a rightward-projecting tail of fewer larger ones. This is the classic distribution expected if just a few large wild animals were hunted to supplement the main domestic kill (cf. also Uerpmann's sheep from Çayönü in fig. 6.1). Such a pattern is typical for most sites in Neolithic Europe; three examples from different regions are given in figure 6.6. The widespread nature of this two-population pattern is revealed by its occurrence at Peschany 1, a first-millennium B.C. site near Vladivostok on the Sea of Japan (Rowley-Conwy 2000; Rowley-Conwy and Vostretsov 1997).

When the two-population pattern is present, there is little doubt that one population must comprise fully domestic pigs under close control, and there is no need to invoke any intermediate status. Single-population distributions are rare in Neolithic Europe, but when they do occur the problem is more difficult. This is the case for two areas: the island of Gotland in the Baltic and parts of the western Mediterranean.

Middle Neolithic assemblages from Gotland provide single-population patterns, and opinion is divided as to whether the pigs were domestic or wild (Lindquist and Possnert 1997 argue for domestic status; Rowley-Conwy and Storå 1997 for wild). The single population pattern is in contrast to that put forward by Benecke (1993), who argued that local domestication was occurring. But there is no evidence for this in the results obtained by Rowley-Conwy and Storå (1997). The status of Neolithic pigs in the east of the Baltic is little known; sometimes small numbers of domestic animals are claimed (e.g., Dolukhanov 1979) but few metrical data are available. Until more data are published, claims for later Mesolithic "intensification" put forward by Zvelebil (1995) are hard to sustain. If late Mesolithic human populations were larger, for example, because they were coastal, then increased hunting pressure might take place, but evidence for a trend toward local domestication is lacking (Rowley-Conwy and Storå 1997).

The situation in the western Mediterranean is also complex. At Arene

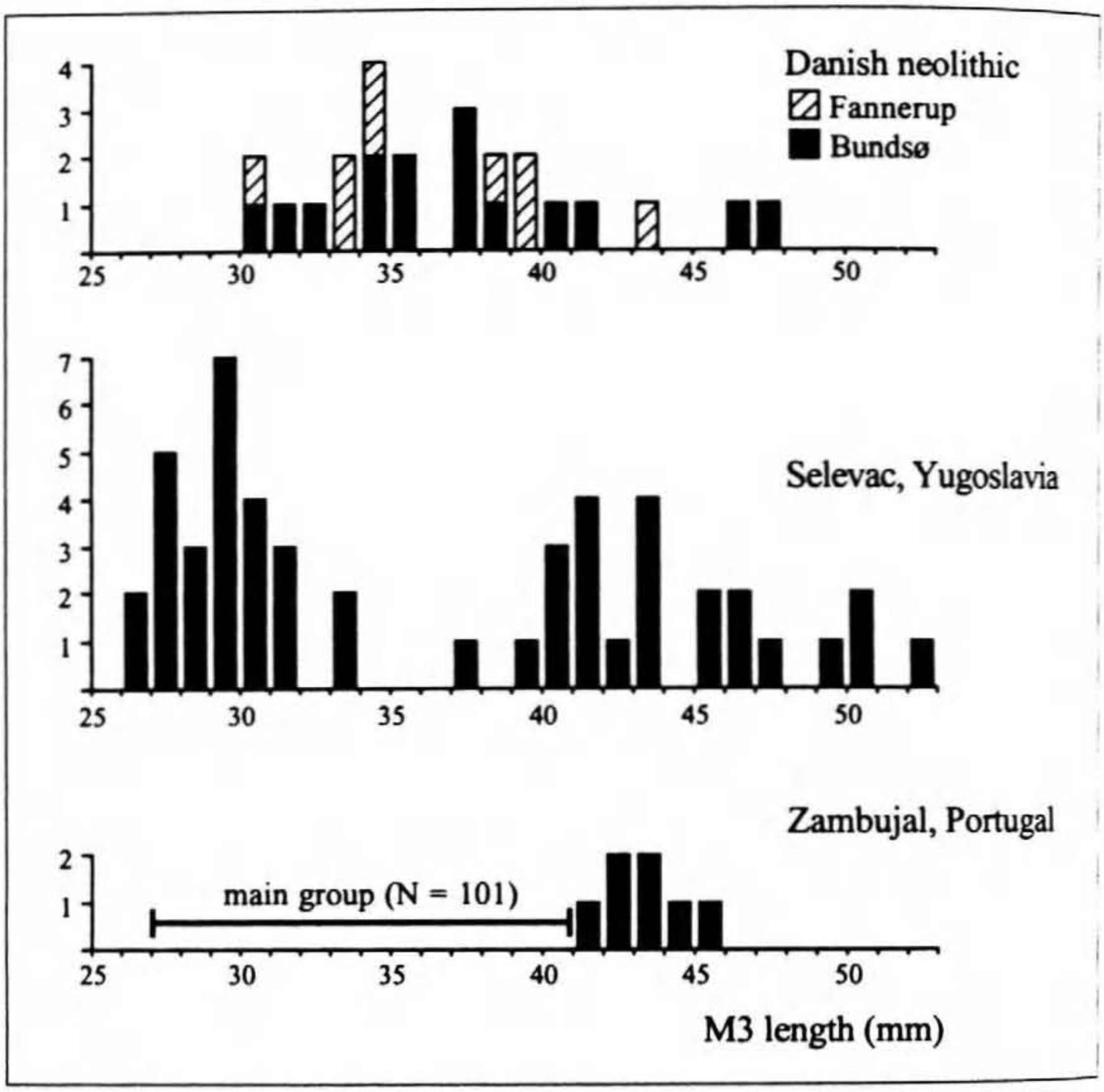

Fig. 6.6. Lengths of lower third molars of pigs. Bundsø from Degerbøl (1939, table 9); Fannerup from Rowley-Conwy (1984, app. 2a); Selevac from Legge (1990, app. 5.1); and Zambujal from von den Driesch and Boessneck (1976, table 22).

Candide in Liguria, pigs are believed to have been wild for most of the Neolithic, based on the coefficients of variation of most (though not of all) elements and on the distribution of naturally shed milk teeth. Such teeth are shed during normal chewing and testify that live (and therefore domestic) animals were penned within the cave. They are found only in the terminal Neolithic and later, while those of cattle and caprines occur throughout the Neolithic sequence (Rowley-Conwy 1997). Shed caprine teeth are commonly found in Neolithic caves (Helmer 1984). The situation in southern France is unclear. Small numbers of Neolithic domestic pigs are claimed, for example, at Gazel (Geddes 1980). Samples are often small and highly fragmented, as at Dourgne (Geddes 1993), making interpretation difficult, but domestic pigs may be absent during the earliest Neolithic (Geddes 1980; Helmer 1987). A further complicating factor has been the claim for early Neolithic and even terminal Mesolithic domestic pigs at Sarsa, Nerja, and Parralejo in southeastern Spain (Boessneck and von den Driesch 1980). None of these caves is free of stratigraphic disturbances at the critical point, so that the bones in question cannot be ascribed to a cultural horizon with certainty (Zilhão 1993). Even if the bones are correctly dated, however, there is no reason to assume that they must derive from domestic animals; metrically they could equally well derive from wild boar (Rowley-Conwy 1995).

Conclusion

I have tried to argue that in most cases the appearance of domestic animals may have been a tidier process than is sometimes envisaged. Evidence for local domestication of cattle and pigs, whether in advance of or after the arrival of the conventional Neolithic, is very thin. In most areas, the evidence is most simply interpreted to support the hypothesis that all the major animal species were introduced from elsewhere—at about the same time. This was usually at the start of the conventional Neolithic, although not always. The western Mediterranean pig problem has been mentioned; and it is possible that in Norway and Ireland some Neolithic cultural items spread ahead of the domestic animals (Prescott 1996; Burenhult 1984, pers. comm.).

New zooarchaeological methods and ongoing zooarchaeological work have been crucial. We are now better equipped than before to understand measurement distributions, although there is clearly a long way to go. A second crucial feature has been the radiocarbon accelerator, which allows the dating of individual animal bones to test whether they are contemporary with the layers in which they are found or whether they are intrusive. This combination of new zooarchaeological and chronometric methods means that it is worth reanalyzing many bone assemblages excavated perhaps many years ago. Rather than dismissing them as useless, we should rework such assemblages in the full knowledge that we may not be able to extract from them as much information as we would hope. At the same time, they will provide some information—and the questions they raise will direct our research when new assemblages appear.

REFERENCES

Aaris-Sørensen, K. 1980. "Depauperation of the Mammalian Fauna of the Island of Zealand during the Atlantic Period." *Videnskabelig Meddelelser fra Dansk Naturhistorisk Forening* 142:131–8.

Benecke, N. 1993. "The Exploitation of Sus scrofa (Linné, 1758) on the Crimean Peninsula and in Southern Scandinavia in the Early and Middle Holocene: Two Regions, Two Strategies." In *Exploitation des Animaux Sauvages a Travers le Temps*, 233–45. Juan-les-Pins.

Boessneck, J., and A. von den Driesch. 1980. "Tierknochenfunde aus vier Südspanischen Höhlen." In *Studien über frühe Tierknochenfunde von der Iberischen Halbinsel* 7, edited by J. Boessneck and A. von den Driesch, 1–83. Munich.

Boessneck, J., J.P. Jéquier, and H.R. Stampfli. 1963. *Seeberg Burgäschisee-Süd: Teil 3, Der Tierreste*. Bern.

Bogucki, P. 1989. "The Exploitation of Domestic Animals in Neolithic Central Europe." In *Early Animal Domestication and its Cultural Context*, edited by P.J. Crabtree, D. Campana, and K. Ryan, 118–34. Philadelphia.

Bökönyi, S. 1974. *History of Domestic Mammals in Central and Eastern Europe*. Budapest.

———. 1977. "The Introduction of Sheep-Breeding to Europe." *Ethnozootechnie* 21:65–70.

Burenhult, G. 1984. *The Archaeology of Carrowmore*. University of Stockholm, Institute of Archaeology, Stockholm.

Cipolloni-Sampò, M. 1987. "Problèmes des débuts de l'economie de production en Italie sud-orientale." In *Premières Communautés Paysannes en Méditerranée Occidentale*, edited by J. Guilaine, J. Courtin, J.-L. Roudil, and J.-L. Vernet, 181–8. Paris.

Clason, A.T. 1979. "The Farmers of Gomolava in the Vinca and La Tène period." *Palaeohistoria* 21:41–81.

Courtin, J., J. Évin, and Y. Thommeret. 1985. "Révision de la stratigraphie et de la chronologie absolue du site de Châteauneaf-du-Martigues (Bouches-du-Rhône)." *L'Anthropologie* 89:543–56.

Davis, S.J.M. 1981. "The Effects of Temperature Change and Domestication on the Body Size of Late Plaistocene to Holocene Mammals of Israel." *Paleobiology* 7:101–14.

Degerbøl, M. 1939. "Dyreknogler." *Aarbøger for Nordisk Oldkyndighed og Historie* 1939:85–198.

———. 1942. "Et knoglemateriale fra Dyrholm-bopladsen, en ældre stenalder køkkenmødding." In *Dyrholm: En Stenalderboplads på Djursland*, edited by T. Mathiassen, M. Degerbøl, and J. Troels-Smith, 77–136. Copenhagen.

———. 1963. "Prehistoric Cattle in Denmark and Adjacent Areas." In *Man and Cattle*, edited by A.E. Mourant and F.E. Zeuner, 68–79. London.

Degerbøl, M., and B. Fredskild. 1970. *The Urus (Bos primigenius Bojanus) and Neolithic Domesticated Cattle (Bos taurus domesticus Linné) in Denmark*. Copenhagen.

Dolukhanov, P. 1979. *Ecology and Economy in Neolithic Eastern Europe*. London.

Driesch, A.E. von den. 1976. *A Guide to the Measurement of Animal Bones from Archaeological Sites*. Cambridge, Mass.

Driesch, A.E. von den, and J. Boessneck. 1976. "Die Fauna vom Castro do Zambujal." In

Studien über frühe Tierknochenfunde von der Iberischen Halbinsel 5, edited by A. von den Driesch and J. Boessneck, 4–129. Munich.

Ducos, P. 1977. "Le mouton de Châteauneuf-lez-Martiques." In *L'Élevage en Méditerrannée Occidentale*, edited by J.-L. Miege, 77–85. Paris.

Edlin, H.L. 1970. *Trees, Woods and Man*. 3rd ed. London.

Ewer, R.F. 1968. *Ethnology of Mammals*. London.

Fuller, W.A. 1960. "Behaviour and Social Organisation of the Wild Wood Bison of Wood Buffalo National Park, Canada." *Arctic* 13:3–19.

Geddes, D. 1980. *De la Chasse au Troupeau en Méditerranée Occidentale: Les Débuts de l'Elevage dans le Bassin de l'Aude*. Toulouse.

———. 1985. "Mesolithic Domestic Sheep in West Mediterranean Europe." *Journal of Archaeological Science* 12:25–48.

———. 1993. "La faune de l'abri de Dourgne: Paléontologie et paléoéconomie." In *Dourgne: Derniers Chasseurs-Collecteurs et Premiers Éleveurs de la Haute-Vallée de l'Aude*, edited by J. Guilaine, 365–97. Toulouse.

Gotfredsen, A.B. 1998. "En rekonstruktion af palæomiljøet omkring tre senmesolitiske bopladser i Store Åmose, Vestsjælland-baseret på pattedyr-og fugleknogler." *Geologisk Tidsskrift* 1998:92–103.

Guilaine, J. 1993. *Dourgne: Derniers Chasseurs-Collecteurs et Premiers Éleveurs de la Haute-Vallée de l'Aude*. Toulouse.

Heinrich, D. 1993. "Die Wirbeltierreste vom ellerbekzeitlichen Siedlungsplatz Schlamersdorf LA 5, Kreis Stormarn." *Zeitschrift für Archäeologie* 27:67–89.

Helmer, D. 1984. "Le parcage des moutons et des chèvres au neolithique ancien et moyen dans le sud de France." In *Animal and Archaeology*. Vol. 3, *Herders and Their Flocks*, edited by J. Clutton-Brock and C. Grigson, 39–45. *BAR-IS* 202. Oxford.

———. 1987. "Les suidés du Cardial: sangliers ou cochons?" In *Premières Communautés Paysannes en Méditerranée Occidentale*, edited by J. Guilaine, J. Courtin, J.-L. Roudil, and J.-L. Vernet, 215–20. Paris.

Higham, C.F.W., and M. Message. 1968. "An Assessment of a Society's Attitude towards Bovine Husbandry." In *Science in Archaeology*, edited by D. Brothwell and E.S. Higgs, 315–30. London.

Jaczewski, Z. 1958. "Reproduction of the European Bison, Bison bonasus (L.), in Reserves." *Acta Theriologica* 1:333–71.

Jarman, M.R. 1976. "Prehistoric Economic Development in Sub-Alpine Italy." In *Problems in Economic and Social Archaeology*, edited by G. de G. Sieveking, I.H. Longworth, and K.E. Wilson, 375–99. London.

Jarman, M.R., and P.F. Wilkinson. 1972. "Criteria of Animal Domestication." In *Papers in Economic Prehistory*, edited by E.S. Higgs, 83–96. Cambridge.

Kelly, R.C. 1988. "Etoro suidology: A Reassessment of the Pig's Role in the Prehistory and Comparative Ethology of New Guinea." In *Mountain Papuans*, edited by J.F. Weiner, 111–86. Ann Arbor.

Lasota-Moskalewska, A. 1998. "Archaeological Reconstruction of the Animal Husbandry at Deby in Kujavia, Poland." In *Harvesting the Sea, Farming the Forest*, edited by M. Zvelebil, R. Dennell, and L. Domanska, 135–6. Sheffield.

Legge, A.J. 1990. "Animals, Economy and Environment." In *Selevac: A Neolithic Village in Yugoslavia*, edited by R. Tringham, 216–42. Los Angeles.

Legge, A.J., and P.A. Rowley-Conwy. 1988. *Star Carr Revisited: A Re-Analysis of the Large Mammals*. London.

Linnard, W. 1982. *Welsh Woods and Forests: History and Utilization*. Cardiff.

Lindqvist, C., and G. Possnert. 1997. "The Subsistence Economy and Diet at Jakobs/Ajvide, Eksta Parish and Other Prehistoric Dwelling and Burial Sites on Gotland in Long-Term Perspective." In *Remote Sensing*. Vol. 1, edited by G. Burenhult, 29–90. Institute of Archaeology, University of Stockholm, Stockholm.

Nobis, G. 1962. "Die Tierreste prähistorischer Siedlungen aus dem Satrupholmer Moor (Schleswig-Holstein)." *Zeitschrift für Tierzüchtung und Zuchtungsbiologie* 77:16–30.

———. 1975. " Zur fauna des ellerbekzeitlichen Wohnplatzes Rosenhof in Ostholstein I." *Schriften des Naturwissenschaftlichen Vereins für Schleswig-Holstein* 45:5–30.

———. 1983. "Wild- und Haustierknochen des frühneolithischen Fundplatzes Siggeneben-Süd." In *Siggeneben-Süd. Ein Fundplatz der frühen Trichterbecherkultur an der holsteinischen Ostseeküste*, edited by J. Meurers-Balke, 115–8. Neumunster.

Payne, S., and G. Bull. 1988. "Components of Variation in Measurements of Pig Bones and Teeth, and the Use of Measurements to Distinguish Wild from Domestic Pig Remains." *ArchæoZoologia* 2:27–65.

Persson, P. 1999. *Neolitikums Början*. Department of Archaeology, University of Gothenburg, Gothenburg.

Poplin, F. 1979. "Origine du Mouflon de Corse dans une nouvelle perspective paléontologique: Par marronage." *Annales Génétique et Sélection Animale* 11:133–43.

Prescott, C. 1996. "Was There *Really* a Neolithic in Norway?" *Antiquity* 70:77–87.

Rosman, A., and P.G. Rubel. 1989. "Stalking the Wild Pig: Hunting and Horticulture in Papua New Guinea. In *Farmers as Hunters*, edited by S. Kent, 27–36. Cambridge.

Rowley-Conwy, P. 1984. "Mellemneolitisk økonomi i Danmark og Sydengland: Knoglefundene fra Fannerup." *Kuml* 1984:77–111.

———. 1995. "Wild or Domestic? On the Evidence for the Earliest Domestic Cattle and Pigs in South Scandinavia and Iberia." *International Journal of Osteoarchaeology* 5:115–26.

———. 1997. "The Animal Bones from Arene Candide: Final Report." In *Arene Candide: Functional and Environmental Assessment of the Holocene Sequence*, edited by R. Maggi, 153–277. Rome.

———. 1998. "Improved Separation of Neolithic Metapodials of Sheep (*Ovis*) and Goats (*Capra*) from Arene Candide Cave, Liguria, Italy." *Journal of Archaeological Science* 25:251–8.

———. 2000a. "Milking Caprines, Hunting Pigs: The Neolithic Economy of Arene Candide in Its West Mediterranean Context." In *Animal Bones, Human Societies*, edited by P. Rowley-Conwy, 124–32. Oxford.

———. 2000b. "East is East and West is West but Pigs Go On Forever: Domestication from the Baltic to the Sea of Japan." In *Current and Recent Research in Osteoarchaeology* 2, edited by S. Anderson, 35–40. Oxford.

Rowley-Conwy, P., and J. Storå. 1997. "Pitted Ware Seals and Pigs from Ajvide, Gotland:

Methods of Study and First Results." In *Remote Sensing,* vol. 1, edited by G. Burenhult, 113–27. Institute of Archaeology, University of Stockholm. Stockholm.

Rowley-Conwy, P., and Y.I. Vostretsov. 1997. "Animal Bones from Peschany 1: Peter the Great Bay, Russian Far East." *EAANnouncements* 23:4–6.

Sinclair, A.R.E. 1974. "The Social Organisation of the East African Buffalo (*Syncerus caffer* Sparrman)." In *The Behaviour of Ungulates and its Relation to Management,* vol. 2, edited by V. Geist and F. Walther, 676–89. Morges.

Uerpmann, H.-P. 1987. "The Origins and the Relations of Neolithic Sheep and Goats in the Western Mediterranean." In *Premières Communautés Paysannes en Méditerranée Occidentale,* edited by J. Guilaine, J. Courtin, J.-L. Roudil, and J.-L. Vernet, 175–9. Paris.

Vigne, J.-D. 1988. *Les Mammifères Post-Glaciaires de Corse. Étude Archéozoologique.* Paris.

Zilhão, J. 1993. "The Spread of Agro-Pastoral Economies across Mediterranean Europe: A View from the Far West." *Journal of Mediterranean Archaeology* 6:5–63.

Zvelebil, M. 1995. "Hunting, Gathering, or Husbandry? Management of Food Resources by the Late Mesolithic Communities of Temperate Europe." *MASCA Research Papers in Science and Archaeology* Suppl. 12:79–104.

NOTE

[1] I would like to thank Albert Ammerman and the University of Venice for organizing the conference at which an earlier version of this paper was delivered, and to all present for useful comments.