Je crois que le premier devoir d'un naturaliste est de s'attendre, avant même de les avoir formulées, à faire, un jour ou l'autre, mais sans regret, le sacrifice de ses conclusions (Boule, 1888:131).

The interpretations of the position and duration of the Solutrean with respect to Fourth Glacial times have varied greatly since the first estimates were made in the last century, but it is interesting to note that the Solutrean has nearly always been considered a relatively short period. Indeed, in one of the earliest (if not the first) attempts to establish the absolute and relative durations of the Palaeolithic industries, the Solutrean is given a life-span of 11,000 years as compared with 100,000 for the Mousterian and 33,000 for the Magdalenian (G. de Mortillet, 1883:627). As it happens, the ratio of Solutrean to Magdalenian duration — one to three — is probably just about correct, judging from recent radiocarbon dates. Most writers have been impressed by the comparative scarcity of Solutrean sites and have assumed — apparently correctly — that it reflects a short temporal extension.

Its precise place in the Alpine scheme set up by Penck and Brückner has oscillated from a position at the Riss-Würm boundary just following the "Warm Mousterian" (Penck,
to a location in post-Würm times along with the Magdalenian, following a short chronology (Obermaier, 1906:244). Between these two extremes the Solutrean has, especially since the work of Commont in the north of France, been definitely fixed in the Würm sequence although this place was by no means precisely set. Commont maintained that the Solutrean in the North dated from the end of the ergeron or last loess, when it had ceased to form (Commont, 1914:603). His work was hampered by the dubious nature of the Solutrean and the absence of Magdalenian in the loess region. Our knowledge of the cave deposits in which the Solutrean is nearly always found is due to the observations of D. Peyrony, brought up to date in recent years by Bordes and given more or less reliable guide-lines by limited radiocarbon datings.

There has been a good deal of consistency in the positions taken regarding the Solutrean climate. For G. de Mortillet, in the work referred to above as well as in subsequent ones, and for such workers as Cartailhac (1886:35), the Solutrean was characterized by a dryer climate than the Mousterian, with far less rainfall and snow, less fog and cloud cover, warmer summers but colder winters; all the result of a withdrawal of the glaciers. Since then most writers have agreed that in general terms the Solutrean occurred during a period of cold, continental-type climate but without the extremely cold passages found in other parts of the Upper
Palaeolithic. It is only in recent years that a reliable picture of the fluctuations within the Solutrean itself has been provided.

In this paper, the chronology of the Solutrean will be discussed within the Late Pleistocene framework given recently (1960) by Movius and by the various commentators on his paper.\(^1\)

The geological criteria used are the traditional ones involving the interpretation of past climates through such phenomena as loess stratification and weathering, the quality and amount of *éboulis* in shelter deposits, the occurrence of clayey or sandy earth deposits, etc., although the most recent criticisms of these methods (e.g., see Judson, in Movius, 1960: 380-81, and the rejoinder, pp. 384-85) have been taken into consideration. It is very likely indeed that many of the criteria traditionally used in interpreting geological phenomena in archaeological contexts are fallacious or need rephrasing; but, unfortunately, the only approach open to the present writer, as to most workers on the periphery of another discipline, has been to utilize the concepts currently

\(^1\) The framework adopted by Combier (1960) is somewhat different. He sees three Recent Würm stadials between the Götweig and the Allerød, and places the Lower Solutrean of the Southwest and the "Protosolutréen" of the Rhône valley at the end of Recent Würm 2, while the Upper Solutrean is placed in the Recent Würm 2-3 interstadial.
available while stressing their provisional nature and the tentative nature of the conclusions reached by means of them.

Only two Solutrean sites — Laugerie-Haute (Dordogne) and La Salpêtrière (Gard) have been seriously studied during excavation with the aim of making an intensive examination of the past climate by other than gross soil characteristics and faunal remains. Unfortunately, the great majority of Solutrean sites has produced no information on which conclusions may be based, although from a few there are indications, usually based on the fauna, which are sometimes useful in corroborating the results given by the better excavated sites.

Bordes (1953:394) has shown that in the Seine Basin the latest Perigordian and the "Proto-Solutrean" are found at the end of Recent Loess IIIb during a cessation of loess deposition which might, if a new subdivision is required, be called IIIc. This arrest, however, is marked by no significant event such as the formation of lehm or even of gravel. This is consistent with a dry, cold climate, somewhat less rigorous than during the loess deposition. Unfortunately we cannot yet be certain at what point in the Solutrean period the loess formation and deposition ceased, i.e., whether it had ceased before the earliest Solutrean occurrence elsewhere, or during the earliest Solutrean phases. It is unfortunate that none of the "Proto-Solutrean" specimens found so far in the loess can be accepted without question.

The end of the loess can probably be equated with the retreat
preceding the Frankfurt and following the Brandenburg moraines, in the Main Phase of the Middle Würm (or, in Bordes' terminology, at the boundary between the end of Wurm III and the beginning of Wurm III/IV) (Bordes, 1957a:572). It is also unfortunate from our viewpoint that this event has never been dated by radiocarbon methods which could then be correlated with the data emerging from the shelter deposits in the south.

For a more clear-cut representation of Solutrean climate, we must use the data from the Solutrean occupation sites themselves. There seems to have been a slight amelioration of the climate during part of the final Perigordian (Noailles burin phase, or V-c, probably equivalent to Recent Loess IIIb), followed by a cold episode which lasted through the Perigordian VI, the Proto-Magdalenian and the Aurignacian V, well into the Proto-Solutrean (level G of Peyrony's excavations at Laugerie-Haute:West) and the Lower Solutrean (level H1). The present evidence suggests that this cold period may have lasted about three thousand years. At Laugerie-Haute: West the Perigordian VI is followed by a sterile deposit of small and large limestone fragments, over which lies the Aurignacian V; this in turn is followed by a still thicker sterile layer from 40 to 100 cm. thick of grayish sand and limestone fragments on which the Proto-Solutrean is localized. Above this comes the Lower Solutrean, which on the West side as on the East is still clearly thermoclastic, in a context of con-
geliffracts or éboulis sec. Until adequate soil analysis has been completed for this site it is not possible to calibrate the exact rate of change during the Solutrean, but on the east side (where the sequence is better preserved) the layers from the Middle Solutrean indicate a milder, probably more humid climate with more sand or clay in the deposits and fewer angular congeliffracts. This trend continues until, probably, Magdalenian III. The late Solutrean and early Magdalenian in other sites, e.g., Fourneau du Diable, Grotte des Eyzies (Dordogne) also reflect this in the breccia containing these industries.

This general reconstruction is confirmed at a number of other Solutrean sites, including some outside the Périgord region. At Le Ruth (Dordogne) where the Solutrean sequence is nearly the same as at Laugerie-Haute, level F (Solutréen inférieur) is found in a yellowish sandy earth which was probably limestone "sand", although Feyrony (1909a,b) does

\[1\text{As will be discussed later, the whole of the Middle Solutrean on the East side seems to reflect milder conditions than does the thermoclastic Lower Solutrean, whereas on the West side of the site the Middle Solutrean still seems thermoclastic, in part at least. However, it appears probable that local exposure conditions within this huge rock-shelter must be taken into account for the apparent discrepancy. The deposits excavated on the East side from 1956 to 1959 are found at the very back of the rock-shelter where exposure, and thus thermoclastic action, might be expected to be less; whereas the Solutrean excavated on the West side is found at the front of the shelter, which would be subject to more severe frost action on the roof above. Bordes' recent excavations in the Lower Magdalenian on the East side of this site have demonstrated that the same conditions are true, with far fewer congeliffracts being found at the back of the shelter than at the front in a given level (personal communication).}\]
not give more details; he does mention, however, that the
Middle and Upper Solutrean were found in brownish earth, which
seems to correspond well with the deposits at Laugerie-Haute.

The information from Roc de Combe-Capelle (Dordogne)
is also incomplete in this respect. According to D. Peyrony
(1943) the levels G to I (from Perigordian V/Lower Solutrean
to Upper Solutrean) had eolian elements indicating a contin-
ental climate less cold than level B following the Perigordi-
an I. There are no details given on the soil of the Lower
Solutrean level, though according to Breuil (1909a) level H
was in yellow sand with breccia formation and heavy rockfall
(presumably Middle Solutrean). Peyrony does mention, however,
that the Upper Solutrean here (level I) was in a loose earth
indicating a milder climate. The sterile level (J) above had
the same composition and probably corresponds to the early
Magdalenian in other sites, while level K, which Peyrony de-
scribes as very cold, may correspond to the end of the Mag-
dalenian.

Bouchud's studies of the fauna from various Périgord
sites confirm the milder climate of the late Solutrean. From
the fauna and avifauna remains at the Grotte de Lachaud (Dor-
dogne) he concluded (1952) on the basis of the presence of
Citellus citellus (spermophile or suslik) and Eliomys quercinus
(garden dormouse) that there had been an amelioration of the
climate from at least the Upper Solutrean to the Magdalenian
II.
Guillien (1943) has pointed out that at such sites as Roc de Sans (Charente) and probably Pré-Aubert (Corrèze) and Fourneau du Diable (Dordogne), the Solutreans seem to have lived around large fallen blocks from which the smaller debris and soil had been washed away by increased water action; he suggests that this indicates a milder climate, and since these sites are all late Solutrean this view sounds reasonable. All this evidence makes it difficult to accept Alimen's tentative interpretation (1950) that the late Solutrean at La Chaire à Calvin (Charente) was characterized first by a moderate cold, then by a severe cold when large blocks fell, after which a polygonal soil formed before the arrival of Magdalenian III groups. It would now be more consistent with what we know of other late Solutrean sites to suppose that the heavy rockfall reflects part of the late Magdalenian climate. Indeed, the more recent excavation at La Chaire à Calvin (see chapter VIII) show that Alimen's interpretation is incorrect.

In a very careful study of the Solutrean made at La Salpêtrière (Gard), Escalon de Fonton and Bonifay (1953) determined that the Lower Solutrean there occurred at a time when the wind action was decreasing rapidly and the cold was increasing. In the Middle Solutrean at the same site the climate became somewhat milder and the humidity increased. It will be appreciated immediately that this is rather similar
to the situation in Southwestern France just described, and although the writers emphasize that they are only describing local climatic conditions, the parallel is probably due to more than coincidence and implies not only that the Solutrean industries in the two areas were about contemporary (as the typology also suggests) but in addition that the climatic circumstances were much the same in spite of the separation between the two areas and the regional variation involved. When their paper was written, the succeeding levels with shouldered points (which they called Upper Solutrean) were shown to have occurred in a period of increasing cold and dryness. This is clearly at odds with the Upper Solutrean in Southwestern France, but the more recent discovery at La Salpêtrière that this "Solutrèan supérieur" is really a quite distinct industry, the Salpêtrien as Escalon de Fonton calls it, removes this contradiction and suggests that if the later climatic correlations with the Périgord region are correct then the salpêtrien may have been contemporary with the second half of the Magdalenian.

Another site outside the Southwest which confirms the milder climate of the more recent Solutrean is Iaturitz (Basses-Pyrénées). Recent pollen analysis by Amélie Leroi-Gourhan (1959) shows that the Solutrean here (couche IIIa, the Solutrén typique of the de Saint-Périers) was laid down during a slightly milder, more humid period when a steppe-park climate reigned.
It seems to have been the mildest period since the Mousterian, and had the highest proportion of trees of any period of the Upper Palaeolithic at Isturitz. It will be shown later, on typological grounds, that this Solutrean is certainly contemporary with part of the Upper Solutrean in the Périgord region, and the climatic reconstruction tends to confirm this position. This is the only Solutrean site where such palaeobotanical analysis has yet been carried out. It should be kept in mind, of course, that the maritime location of Isturitz must have brought factors into play which were not present in the sites further north; but the general lines seem to correlate well.

Thus we obtain the following picture of Solutrean climate. The Proto-Solutrean and Lower Solutrean witnessed a lowering of temperatures with strong frost action on the ceilings of the rock-shelters when fairly large, angular fragments were detached. According to Bordes (1958a:244), the upper part of the Lower Solutrean level on the East side of Laugerie-Haute seems to have experienced cryoturbation which rounded the angular limestone fragments. The interesting thing would be to determine at what point the change set in during the Middle Solutrean; there may have been no sharp break climatically, just as there was no break demographically, but by at least the time of the Middle Solutrean of Laugerie-Haute East there are indications of a milder régime, with
less rockfall and more clay and earth in the deposits. This continued, to reach a climax in the most recent Solutrean and the earliest Magdalenian, and does not seem to have been halted by another cold spell until about Magdalenian III in Périgord. In the late Solutrean especially a good part of the deposits seem to have been derived from stream action off the plateau above, and from wind-borne soil.\(^1\) We can assume, then, that while still cold the Middle and Upper-Final Solutrean at Laugerie-Haute, and elsewhere in the southern half of France, was more moderate, with the cold, dry boreal conditions of a continental-type climate producing long, cold winters with short but fairly warm summers. Certainly nothing in the fauna collected from Laugerie-Haute contradicts this, and in every level reindeer makes up by far the greatest part of the animal remains, followed usually by horse. It is unfortunate that Bouchud's detailed analysis of the fauna from a number of important Solutrean sites has not yet become available, for a knowledge of the proportions of species and subspecies(e.g., of forest vs. tundra reindeer) would be most valuable in this connection. His analysis of Peyrony’s Laugerie-Haute fauna will be especially welcome.

Movius (1960:369) has tentatively suggested that the milder phase indicated by the Middle Solutrean to the Lower

\(^1\)And possibly, as F. Bordes has remarked to the writer, through terre à godasse or soil brought into the shelter on the feet of the occupants, which can accumulate very quickly especially in wet weather.
Ma. Balkanian may correspond to the retreat of the North European ice-sheet from the Frankfurt to the Pomeranian moraines; presumably, then, the Lower and Proto-Solutrean corresponds in time to the Frankfurt moraine, all during the period between the Paudorf and Bölling oscillations, i.e., in what he calls the Main Phase of the Middle Würm. In a criticism of this paper (ibid., p. 377) Bordes states that he prefers to consider this milder period as a true interstadial, the Würm III-IV, on the basis that at Laugerie-Haute there is a definite change in the nature of the sediments as the thermoclastic elements become relatively rare. This point of view can probably be upheld, in spite of the poor showing this interstadial or oscillation makes in the cave deposits as contrasted with, say, the Göttweig Interstadial at La Ferrassie, levels B and F; but then, the Paudorf is equally lacking in the cave deposits. However, this is a point which does not directly involve the aim of the present paper, and Müller-Beck's provisional use of the term "Dordogne Phase" to describe this climatic oscillation will probably prove a useful one (Müller-Beck, 1961:442). 1

It was hoped that the results of a large number of charcoal samples collected by the writer from the Lower, Middle, Upper and Final Solutrean levels at Laugerie-Haute:

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1 De Heinzelin (1961:436) prefers to name this interstadial after the site of Laugerie-Haute, as part of what he and Tavernier call the Ep1-Pleistocene period, from the early Solutrean to the Allerød.
West and submitted to Gröningen for radiocarbon analysis, would be available by the time this paper was written. Unfortunately, at this date they are still not forthcoming and thus the Solutrean is represented by a single Carbon-14 dating, from a sample taken by Bordes in the Lower Solutrean (couche 31) of Laugerie-Haute:East in 1957. The results of 690-1888 gave an age of 20,650 ± 300 years (18,700 ± 300 B.C.). However, if Bordes is right in believing that the Proto-Magdalenian at Abri Pataud and Laugerie-Haute East should fit in at about 18,250 B.C. (Ibid., p. 368, based on the mean of seven C-14 dates) then this dating for the Lower Solutrean is probably too old. The Aurignacian V has to fit in here somewhere too. If it is too ancient by the same order of magnitude as the Proto-Magdalenian (couche F) of Laugerie-Haute:East (by about 1,500 years), then a guess at the beginning of the Lower Solutrean would be, in round figures, about 17,000 B.C. The Proto-Solutrean would be somewhat older. Until a dating for the end of the Solutrean or the earliest Magdalenian is known we can do no more than speculate about the length of the Solutrean period, even in Périgord. But if the recent Carbon-14 datings for the Magdalenian III at Altamira and El Juyo in Cantabria are reliable (13,540 B.C. and 13,340 B.C. respectively), then we might reasonably expect the earliest Magdalenian to appear around 15,000 B.C. In all probability future datings will show that the duration of the Solutrean
occupation ranges from a maximum of 3,000 years to a minimum of 2,000 years in Southwestern France.