minimum moment of inertia, as required by spin-orbit coupling theory.

Finally, there is the suggestive fact that the lunar moments of inertia can be explained very consistently in terms of a distribution of mascons in which (*2*) we attribute to the Occultum and Marginis basins mascons of the masses we have derived above.

MALCOLM J. CAMPBELL
BRIAN T. O'LEARY
CARL SAGAN

Center for Radiophysics and Space Research, Cornell University, Ithaca, New York 14850

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4. Because it is derived from only 25 coefficients, the spatial resolution is rather poor: a point mass expanded by such a limited set of coefficients will have its mass reproduced to an accuracy of about 80 percent; however, one-half of this mass will appear to lie outside a circular area with selenocentric half-angle 22°. The limited number of coefficients also restricts the number of distinct mascons which can be depicted. In particular, along the equatorial belt a maximum of four separate peaks can be shown. Their locations will be determined by the largest well-spaced mascons in the region; smaller mascons will be merged into these larger peaks and will affect somewhat the masses and location indicated by these peaks.
5. *Atlas of the Farside of the Moon: Publication of Science* (Soviet Academy of Sciences, Moscow, 1967), vol. 2.
6. The masses of the mascons under the lunar maria are closely proportional to the cubes of their diameters, as predicted by a variety of reasonable models (*2*).
7. E. A. Whitaker, unpublished results.
8. *Lunar Farside Chart LFC-1* (National Aeronautics and Space Administration, Government Printing Office, Washington, D.C., 1967).
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12. It is worth noting that the much more precise estimates of the high-order tesseral harmonics in the earth's gravitational field are based upon almost equally patchy observations. See, for example, C. Oesterwinter, *Space Res.* **6**, 999 (1966).
13. We thank B. Tierney, C. Gossett, J. Winters, and Y.-S. Yang for their assistance, and R. Baldwin for a preprint of his paper. We are grateful to R. Eggleton for his analysis of Lunar Orbiter photography. Supported in part by NASA grants NGL-33-010-005 and NGR-33-010-082.

24 March 1969

Prehistoric Investigations in Southeastern Turkey

Abstract. *An archeological survey of the upper Tigris-Euphrates basin in Turkish Mesopotamia revealed a very early phase farming village and a nearby developed phase farming village. Late prehistoric developments in this region are critical to understanding of the beginnings of trade and metallurgy.*

In 1963 we had undertaken a surface survey for sites which might yield information about the beginnings of food production in the archeologically unknown southeastern provinces of Turkey (*1*). In the spring of 1964, test excavations indicated that the mound called Çayönü (38°16′N; 39°43′E) near Ergani, northern Diyarbakir province, had been occupied by farmers as early as the latter part of the 8th millennium B.C. Çayönü is a low mound of about 200 m in diameter, adjacent to a tributary of the upper Tigris. Our exposures yielded a superficial occurrence of pottery near the surface only, then an inventory of flint, obsidian, ground stone, and bone artifacts, these being objects which are normally found in an early village site in southwestern Asia. The unusual features of the inventory were the stone foundations for at least one rather substantial building and the use of hammered native copper in a context before the appearance of pottery.

In 1968, we reopened Çayönü after an intensive collection of its surface yield on 83 randomly selected 5-m squares. Two of these squares, one with a rather heavy yield of surface potsherds and one with no sherds but with a heavy flint and obsidian yield, were selected for test excavation. The former square contained a stone slab crypt with the flexed skeleton of a juvenile and three pots of the late 3rd millennium B.C. The occupation on the site at this time appears not to have spread over the whole mound nor to a very great depth. In the second test square, the inventory was similar to that of our deeper exposures in 1964, without pottery but with quantities of flint, obsidian, and ground stone tools, and a portion of a curious "grill" plan building (another example appeared in the fifth level of the excavation in 1964).

A pair of larger exposures were made to enlarge architectural clearances begun in 1964. Indication of domesticated wheat is still not specific but impressions of evidently domesticated barley continued to appear in fragments of mud-brick. Sheep, pig, the dog, and very probably the goat are evidenced by the animal bones as domesticates.

A second small mound, Girik-i-Haciyan (38°14′N; 39°58′E), again in northern Diyarbakir province near Ekinciyan village, was tested. Intensive systematic surface surveys of 105 5-m squares confirmed our gross 1963 impression of a Halafian phase occupation and indicated more homogeneity in surface artifact densities than had the mound at Çayönü. Only three 5-m squares were opened, and these to no great depth. The Halafian painted pottery of Girik-i-Haciyan is very similar to that from such Iraqi sites as Arpachiyah and Banahilk (*2*), but is present only in low percentages in the tests (and in the systematic surface collection). The bulk of the Girik-i-Haciyan pottery is simple ware.

Our exposures add to general knowledge of the total inventory of Halafian artifacts in chipped flint, obsidian, ground stone, and bone. Five samples for radiocarbon age determination were collected at Girik-i-Haciyan with which the chronological place of the Halafian phase may be more fully established. Present evidence suggests the time to be in the later 6th or earlier 5th millennia.

The late prehistory of the slopes and piedmont of the Zagros Mountains in Iraq and Iran and of the hill country and higher hinterland of the east Mediterranean littoral is now available in broad outline (*3*). Çayönü and Girik-i-Haciyan lie between these two regions on the piedmont of the southward slopes of the Taurus Mountains. Present evidence would include the Taurus piedmont as one of the typical stretches of the natural habitat zone of the potential plant and animal domesticates of southwestern Asia (*4*). What gives the Taurus piedmont region special interest is its inclusion of or adjacency to sources of obsidian (the basis of the earliest bulk-carrying trade) and of copper. The hammered bits of native copper of Çayönü are hardly true metallurgy, in a pyrotechnical sense, but they presage mankind's general use of metals.

ROBERT J. BRAIDWOOD

Oriental Institute, University of Chicago, Chicago, Illinois

HALET ÇAMBEL

Department of Prehistory, Istanbul University, Istanbul, Turkey

PATTY JO WATSON

Department of Anthropology, Washington University, St. Louis, Missouri

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21 March 1969; revised 24 April 1969

Oldest Known Terrestrial Arachnids

Abstract. *New finds of nonscorpionid arachnids in the Lower Devonian Nellenköpfchen Shale of Alken an der Mosel, Germany, give valuable information on the first appearance of terrestrial arachnids.*

Fossil arachnids are fairly abundant in Upper Carboniferous (Pennsylvanian) deposits, but from earlier formations very little is known of this important group. The first arachnids to appear in the geological record are the scorpions, which occur both in the Silurian and Devonian and continue up to recent time. When the Silurian scorpions were first discovered, scientists generally regarded them as the first arthropods to appear on land. However, more recent finds and an increased knowledge of the morphological structures of the early scorpions indicate that they were aquatic forms breathing with gills like the contemporaneous eurypterids (*1*).

Devonian nonscorpionid arachnids have been described from the Rhynie Chert in Scotland. The arachnids belong to the orders Acarida (*Protacarus*) and Anthracomarti (*Palaeocharinoides* and *Palaeocharinus*), and possibly to the order Araneida (*Palaeocteniza*) (*2*). The Acarida and Anthracomarti are very small, only 0.3 to 3.5 mm long. Because marine fossils are lacking in the Old Red sequence at Rhynie, the age of the chert has been difficult to determine. In general the beds have been regarded as Middle Devonian, but more recently a late Lower Devonian (Emsian) age has been suggested (*3*).

Our find of fossil arachnids gives valuable information on the first appearance of nonscorpionid arachnids. The fossils occur in the so-called Nellenköpfchen Shale in a quarry near the town of Alken an der Mosel in the Western part of Germany. The age of the beds is upper Lower Devonian or Emsian. The dark grey shale, which probably was deposited under more or less anaerobic conditions, has yielded an important fossil flora and fauna, the former with algae and other plants (*Chaetocladus hefteri, Dawsonites jebachensis* a.o.) (*4*), the latter with eurypterids (*Parahughmilleria* n. sp. a.o.) and some mollusks and ostracoderms [*Pteraspis* (*Rhinopteraspis*) *dunensis a.o.*] (*5*, *6*). During my studies of the eurypterids, I have noticed several arthropod specimens which I recognized as arachnids similar to those known from the Upper Carboniferous of Europe and North America.

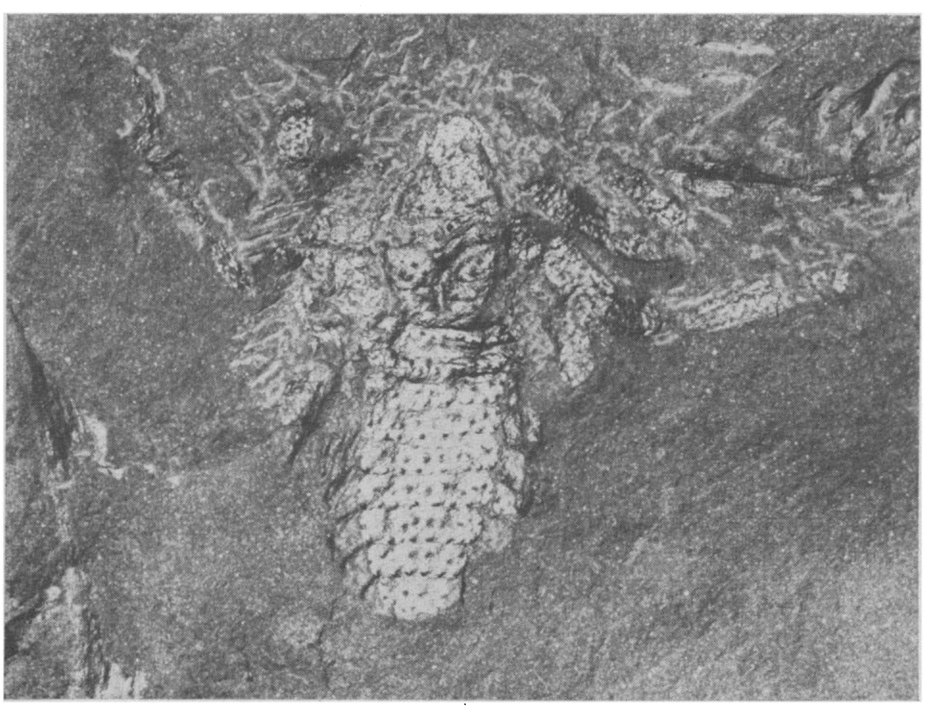

Fig. 1. A fossil arachnid from the Lower Devonian (Emsian) of Alken an der Mosel, Germany (No. SMF VIII 30 of the Senckenberg Museum und Forschungstelle, Frankfurt am Main, Germany)

The well-preserved large specimen (Fig. 1) as well as its counterpart in the shale has been cleaned, and the different structures exposed in the two pieces are combined in the reconstruction (Fig. 2). Only the dorsal surface of the body is demonstrated. The elongate body (12.5 mm long) has a large, nearly triangular prosoma (cephalothorax) which is attached to the opisthosoma (abdomen) along a broad juncture. The inflated median portion of the prosoma has transverse furrows indicating a primitive segmentation present also in certain Carboniferous forms such as *Trigonomarthus* (*7*). Four of the five pairs of legs of the arachnid are more or less preserved. They are nearly uniform in shape and size, and the surface is covered by minute tubercles. Each leg has a blunt distal joint (tarsus) which apparently was provided with a pair of small claws similar to those found in related Devonian species from Scotland, and in most Recent arachnids. This type of leg is characteristic of terrestrial forms. In the aquatic eurypterids the distal joint of the legs had a strong terminal claw or spine, often flanked by two spines evidently homologous with the two arachnids claws (*8*).

The oblong opisthosoma (abdomen) is transversally divided into nine segments, and longitudinally by two furrows into one median and two lateral areas. The opisthosoma and parts of the prosoma are provided with prominent knobs or tubercles.

The present species, which is characterized by its elongate body and broad juncture between the prosoma and opisthosoma, probably belongs to the extinct order Trigonotarbida of which one family is known from the Devonian and four from the Carboniferous. Our species seems to belong to the family Palaeocharinidae which is represented by two genera in the Devonian of the Rhynie. However, the German form differs considerably from the Scottish ones and evidently belongs to a separate genus.