New Approach to the Problem of Man's Origin

Helmut de Terra

That the process of human evolution must be seen in a geologic perspective, and also that it involves fossil evidence of Old World primates of the Tertiary epoch, has long been realized. Precisely in what manner, and in what geologic period, the emergence of truly hominid forms occurred—whether from ancestral anthropoid apes or from a less specialized form—has to this day remained an unsolved puzzle. A few students of this problem have hypothesized an early, nonanthropoid origin of the evolutionary line leading to man (*1*), although the anthropoid theory of human origin is generally favored over any other interpretation.

It therefore came as a surprise to most anthropologists and paleontologists when a Swiss paleontologist, J. Hürzeler of the Natural History Museum at Basel, stated that *Oreopithecus bambolii* Gervais from the younger Tertiary of Italy was an ancestral hominid. No manlike creature had hitherto been recorded from a geologic period as remote as the beginning of the Pliocene millions of years ago. Although that fossil had in 1872 been assigned to the Old World monkeys, certain scholars, such as Forsyth Major and G. Schwalbe, had long ago called attention to anatomical characteristics suggestive of a phylogenetic position different from the one originally assumed by Gervais.

A comparative study of European primate fossils by Hürzeler led him to reexamine an impressive number of skull fragments of *Oreopithecus,* mostly loaned from Italian collections. Among them were several mandibles, and the proximal parts of a femur and ulna. Hürzeler's first description of the dentition (*2*) was followed by a shorter publication in 1954 (*3*) that called attention to a unique combination of features more manlike than simian: closed dental rows; bicuspid shape of the anterior premolars; vertical position of the incisors; relatively small canines; humanlike proportionate length of teeth; rounded but nearly vertical mandibular symphysis; mental foramen at or above the medium height of the mandibular corpus; the ascending ramus generally concealing the last molar completely; zygomatic arch beginning either above the first molar or even above the posterior premolar, indicating a short face; and hominid shape of the ulnar fragment.

While Hürzeler's findings indicate a reassessment of man's pedigree, they also renew our interest in the European field as rivaling other regions, such as Africa and India, with respect to fossil evidence of this kind. The last aspect will not surprise those who are acquainted with the geologic conditions that created environments favorable to higher-primate life in the Miocene and Pliocene periods of Europe. Such fossil remains are known from regions ranging from the eastern Alps and the Vienna basin clear across Europe to France and Spain. Hence the merit of Hürzeler's studies lies partly in his calling attention to the prospects on European soil for a concerted attack on one of the most challenging puzzles of natural science: the descent of man. With such prospects in mind, I volunteered last spring to aid Hürzeler's studies in the coal-mining district of Grosseto Province in Italy, where he and others before him had obtained stray fragments of *Oreopithecus.*

Thanks to the financial aid of the Wenner-Gren Foundation for Anthropological Research, it was possible for Hürzeler to lecture last March in New York and at Harvard University and present his fossil material. It then appeared that the problem, as stated by him, called for additional specimens and geologic field studies that might permit better judging of the merits of his claim with regard to the hominid affinities of *Oreopithecus* and its geologic age. Such an investigation was initiated last spring and summer with grants from the same foundation under its auspices, and with the cooperation of the Natural History Museum at Basel, the University of Pisa, and the Institute of Human Paleontology in Rome.

Notwithstanding the great interest evinced by the Italian institutions, it was not possible on short notice to assemble a team that could work on a schedule that would allow the participating members to spend all their time together in the field (*4*). Owing to previous arrangements, the actual geologic mapping was entrusted to L. Trevisan of the University of Pisa, whose colleague E. Tongiorgi is expected to continue with his paleobotanical contributions to the problem.

Finding a Site

Considering that fossil specimens had previously been found only in coal-mining operations underground, most of which had long ago been abandoned, it seemed important to locate a surface outcrop of the fossiliferous coal suitable for excavations. Such a prospect appeared at the mine of Ribolla near Grosseto at a place called San Feriolo. Here the coal appears in faulted position on the surface, and it was found to contain numerous fossil tree trunks, suggesting a swampy forest in marginal position to the coal basin. This spot seemed all the more promising because of indications of two separate bone beds recorded in an ancient drilling log some 800 feet from the surface outcrop. Unhappily, these expectations for finding the *Oreopithecus* horizon at this place did not materialize. Surface trenching in various directions yielded no fossil bones, possibly because of the deep alteration that the coal has suffered from fracturing and weathering.

I then inspected other localities in the vicinity of Ribolla, surveying parts of the basin and finding some extensive coal outcrops at Casteani and Aquanera, where local informants vouched for previous finds of fossil bones, including *Oreopithecus* mandibles, which had been turned over to museums in Italy. At these places surface searching was of no avail, the ancient coal dumps having disintegrated and partly burned.

No sooner had these hopes been abandoned when news came that the coal mine of Baccinello was to be reopened at the end of May. As it turned out, this event came to offer the finest chances that Hürzeler and I had anticipated on the basis of previous finds, among which was a complete skull and other skeletal parts, some of which had been salvaged in 1951 or 1952. The earlier finds at Baccinello had given rise to the claim that a complete skeleton had been found, which may well have been the case, but

The author is a member of the staff of the department of geology at Columbia University.

proper supervision was not then available.

While the first attempts at excavation at Ribolla disclosed weathering and structural factors inimical to preservation of fossil bones, future studies of similar coal outcrops may well result in more positive finds. No less than 17 occurrences of lignite coal are known from Tuscany, scattered over some 1000 square miles and associated with intermontane basins containing fresh-water formations of the younger Tertiary. Until this extensive area has been thoroughly searched, the mine at Baccinello and its vicinity will remain the most promising locality for an exhaustive study of the *Oreopithecus* problem.

Excavations

Mining operations at Baccinello started at the beginning of June, and with them appeared right away the first fossil fragments of *Oreopithecus*. An inspection of the coal some 400 feet underground by Hürzeler and me revealed no proper bone bed. The first fragments, a lower mandible and pieces of ribs and vertebrae, were picked up in the colliery from the first diggings. The underground chamber was reached by what to us seemed a hazardous descent by cable car and ladders. A special reflector lamp borrowed for this first inspection illumined the coal all right but revealed only one bone fragment. In the following weeks and months, new specimens appeared intermittently over a distance of some 250 feet and at the same level. Hürzeler estimated that they belonged to no less than five individuals. Such local concentration of fossil primate remains would seem to be unique among all the sites known so far from the younger Tertiary.

Beginning with the first finds, I initiated a control of the mined coal whereby pieces with bone fragments were hand picked in the colliery before the coal was fed into the crusher. Obviously this method would never do in salvaging the larger parts of the skeleton so we considered our chances for excavations underground. It was discouraging, to say the least, to watch precious specimens being hacked to pieces when we needed a complete skull, pelvis, and limb bones.

Under ordinary circumstances, it might have been expedient to apply to the government to protect the site by enforcing a temporary stoppage of mining operations. Such interference would have given us a chance to exploit our prospects. Unhappily, the circumstances would never permit such drastic action. The mine had been reopened through the initiative of a miners' cooperative, and it provided a livelihood for 120 men and their families, most of whom had lived through years of near-starvation from unemployment. In this desperate struggle for ultimate acquisition of the mine, no heed could be paid to scientific aims. The only chance to excavate for fossils underground was to supplement the labor force at our cost and, after some exploratory diggings, to start mining coal at a place reserved for this purpose. Considering the dilapidated condition of the mine, this would have required special equipment and technical supervision at a prohibitive cost.

Geology

Meanwhile, invitations had been sent by G. Caputo for a conference to be held at Grosseto that would permit our Italian colleagues to discuss their chances for cooperation. How great their interest was is evident from the number of participants who represented ten institutions. They were given a chance to visit the mine and to inspect the first finds. Existing arrangements having found their approval, I then started to look over the terrain for stratigraphic clues and geologic prospects for surface excavations. The question of the geologic age of the *Oreopithecus* horizon depended on finding and surveying a stratigraphic sequence that was preferably undisturbed by faults such as those that characterize the immediate vicinity of the coal workings at Baccinello.

The small mining community of Baccinello lies in the hill country of the coastal region of Tuscany, some 30 miles distant from the Tyrrhenean Sea and 17 miles east of Grosseto, a provincial capital between Rome and Pisa. Like other coal mining settlements in Tuscany, Baccinello has seen better days—for example, when soft coal mining was profitable, as it was during the last two world wars.

The coal, a lignite, occurs in at least three layers within a basin structure composed of fresh-water and marine sediments regarded as ranging from the middle Miocene to Pliocene (*5*, *6*). The only commercial coal is found close to the base of the sequence, with a thickness varying from 6 to 9 feet (Fig. 1). This constitutes the critical horizon for *Oreopithecus* as evidenced by the latest finds at Baccinello and by the many fossil bones encountered in the same lignite during previous mining operations at Ribolla, Casteani, Aquanera, and Monte Bamboli.

At these places, bones of *Oreopithecus* were found long ago in association with mastodon, *Anthracotherium,* antelopes, *Hyaenarctos, Mustela, Sus,* crocodilian, and chelonian remains. To those contemporaries of *Oreopithecus* must be added some new forms, still to be identified, that Hürzeler found last summer in the Baccinello lignite: jaw bones of hare and skeletal fragments of snakes

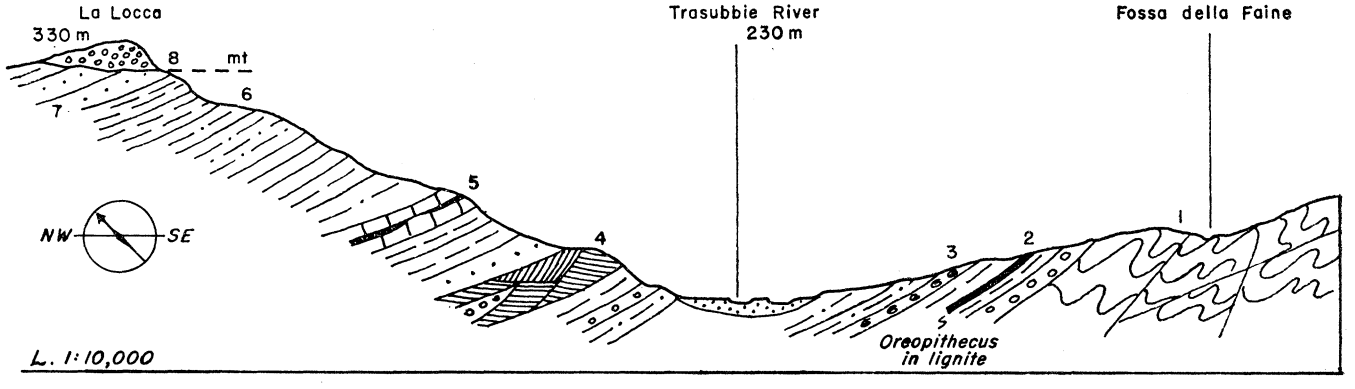

Fig. 1. Geologic sequence with *Oreopithecus* horizon at Baccinello. *1*, "Argille scaliose," marine Cretaceous to (?) Eocene; *2*, conglomerate, sand and lignite with clays and marls; *3*, *Cardium* marl and fine sand; *4*, cross-bedded sand, pebbly sand, and sandy marl; *5*, lacustrine limestone with lignite and shaly marl; *6*, *Hipparion* clay and sandy marl; *7*, pink sandstone and sandy marl; *8*, red conglomerate with oyster banks and fossiliferous marl; *mt*, major marine transgression.

and birds. All these fossils, including those of *Oreopithecus,* bear a black patination. Plant remains are relatively rare and are preserved in fresh-water marls and clays either above or below the lignite. Fresh-water molluscs and ostracods are commonly encountered in the lignite.

A geologic section taken 1 mile northeast of the underground *Oreopithecus* locality at Baccinello (Fig. 1) disclosed a second, if less important, lignite forming a layer but a few inches thick in lacustrine marl containing fresh-water shells and plant remains. A third coal bed was found outside of this region, at Arcille, where a soft, brown coal, up to 8 feet thick, is underlain by marine clay and marl of Pliocene age. Here Hürzeler excavated last year a fauna of fossil land vertebrates with *Myomis,* other rodents, and amphibians.

The paleogeographic conditions that favored repeated swamp formations resulted from coastal basins where temporary ponding of streams was repeatedly interrupted by invasions of the seas. The first invasion was brief, as indicated by a thin marine marl crowded with *Cardium* shells (Fig. 1) and containing some small Foraminifera some 30 feet above the oldest lignite. The second invasion was a major marine transgression that deposited fossiliferous clays and oyster banks over red conglomerates. Derived from terrestrial detritus, these conglomerates rest unconformably on tilted pink sandstone, clays, and fresh-water marls containing teeth of *Hipparion,* the three-toed horse, beaver, and other bones of land vertebrates. Hence the lignite series with *Oreopithecus* and the overlying *Hipparion* clays were tilted prior to this major marine transgression.

Whether these events occurred in the lower Pliocene or in a late phase of the upper Miocene will eventually be decided by identifications of the marine and vertebrate fossils found above the *Oreopithecus* horizon. Following the major marine transgression, the sea claimed this region for a longer time, as indicated by the presence of more than 100 feet of conglomerates, pebbly sands with fossiliferous marine marls and clays intercalated, and subsequently replaced by fresh-water deposits. The thickness of the entire sequence may possibly exceed 1000 feet.

As for the geologic age of *Oreopithecus,* it appears that it was contemporary with the Pontian fauna of Europe (lower Pliocene or upper Miocene, according to a classification adopted in France). Last October Hürzeler reported to me that he had found in the *Hipparion* clay forms such as *Hipparion gracile* Kaup, *Sus choeroides* Pomel, *Antilope gracillima* Weithofer, *Antilope haupti* Weithofer, *Steneofiber jaegeri* Kaup, and further a hare, two kinds of deer, and a primate (? *Oreopithecus*). Since both antelopes and *Sus choeroides* had previously been found in the lignite with *Oreopithecus,* it seems reasonable to assign this form to the lower Pliocene.

Taking into consideration the presence of two fossil primate horizons at Baccinello within an unbroken geologic sequence, there can be little doubt that this region can furnish other important information on *Oreopithecus,* its environment, and its relationships with the Pontian fauna. In this connection, it should be remembered that the lower Pliocene of Europe has furnished a number of higher primate specimens in association with faunistic elements, many of which appear to have been derived from western Asia and Africa.

Oreopithecus Material

The *Oreopithecus* material collected last summer and autumn consists of the following specimens: a nearly complete skull; a portion of the lumbar and sacral sections of the spine; the major articulated portion of a hand; two mandibles, one with eight teeth attached, and the other, while toothless, showing the rounded mandibular symphysis and the high position of the mental foramen; an upper jaw with six teeth and palate intact in addition to the junctions with the zygomatic arch; one fragmentary upper jaw with one molar attached; various skeletal parts and the milk tooth of a child; several isolated foot bones; and diverse finger bones. In addition, Hürzeler was able to obtain from a museum at Siena an important skull fragment from the type locality of Monte Bamboli showing the left orbital region, the right zygomatic arch, the roots of teeth of the right upper jaw, and the occipital portion of the brain case. The skull and jaw fragments were in crushed condition and require careful reconstruction.

The new material is bound to clarify the issue previously raised by Hürzeler concerning the hominid status of *Oreopithecus.* While he is at present preparing a special paleontological report for an American professional journal, I for my part, feel that it is important to relate some translated passages from a letter written on 26 October by G. Heberer, professor of physical anthropology at the University of Göttingen, commenting on the fossil material:

"I visited with Dr. Hürzeler a week ago in Basel and examined the new *Oreopithecus* material. On that occasion we also discussed the previous finds. . . . I have carefully examined the ulna fragment which I cannot help but consider hominoid or even hominid. Unfortunately the new skull is badly crushed and will require much effort at reconstruction. It exhibits nevertheless the absence of a sagittal suture, and a curious divergent alignment of the posterior parts of the zygomatic arches. The eye

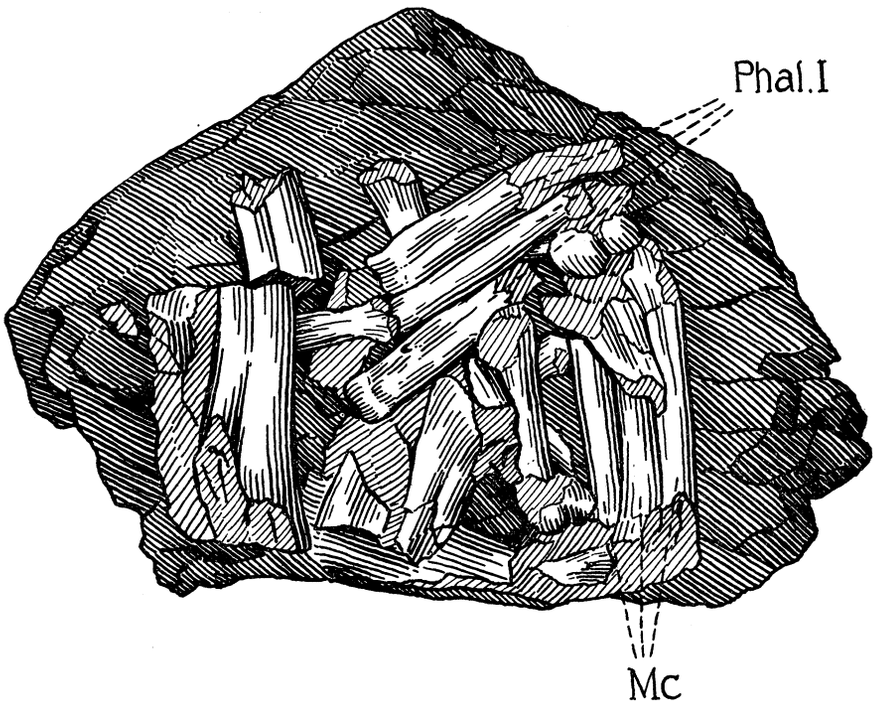

Fig. 2. Articulated portion of a hand of *Oreopithecus* from Baccinello (natural size). Mc, metacarpal; Phal. I, first phalanger.

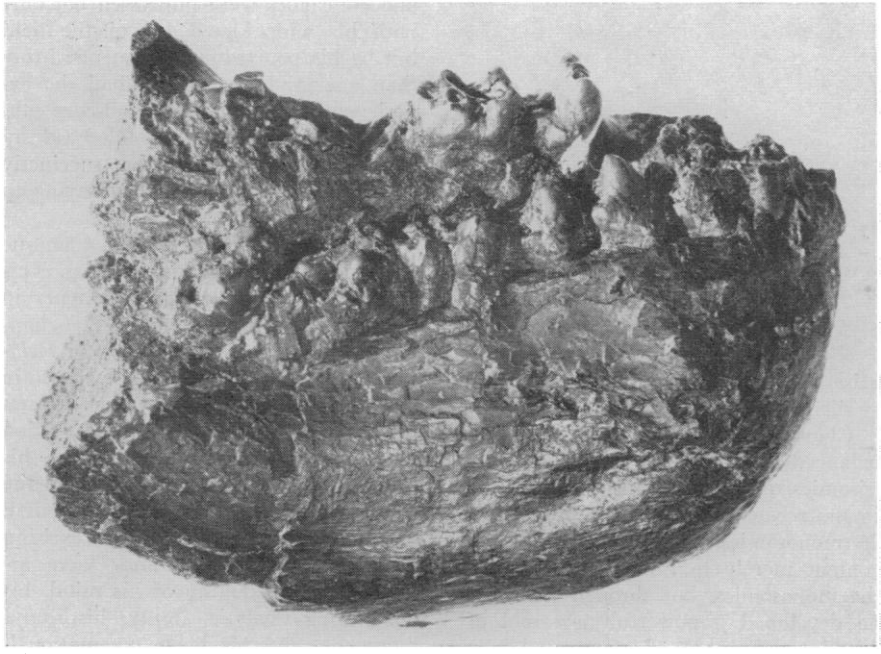

Fig. 3. Lower jaw of *Oreopithecus*. [Courtesy of the American Museum of Natural History]

sockets stood nearly vertical and were not slanted backward. Both of us noticed an angularity of the outer orbital margins. This feature is reserved to the hominids. Of special significance is a portion of the lumbar section of the spine with relatively large vertebrae. This may well indicate that *Oreopithecus* used the hind extremities chiefly for locomotion. Yet this need not necessarily indicate a bipedal gait or a forerunner of it. More comprehensive comparisons will be required to decide this issue.

"The combination of (hominid) features is already so specialized (in *Oreopithecus* as to make their evolution outside of the family of the Hominidae not very likely. . . . Hence my last visit with Dr. Hürzeler has altogether strengthened my belief that *Oreopithecus* is an early hominid of the subhuman phase of hominid phylogeny. In my contribution to *Primatologia* (a new handbook on primates) I have designated the Oreopithecinae as a subfamily of the Hominidae (7). On the basis of the new finds I see no reason for changing my opinion. Hence my interpretation agrees rather closely with that of my colleague Hürzeler."

The environment of *Oreopithecus* was undoubtedly that of a warm, humid, swamp forest occupying the lowlands of a hilly landscape adjoining the coast. More specific information can be expected from a chemical, petrologic, and palynologic analysis of the lignite samples collected at Baccinello. These analyses will be carried out by experienced specialists at the Amt für Bodenforschung at Krefeld, Germany (8). These investigations will be aided by the paleobotanic studies of Professor E. Tongiorgi of the University of Pisa, and those of Dr. Walter Berger of Vienna who has undertaken a complete revision of a large collection of fossil plants from the lignite of Gabbro in Tuscany (9).

Conclusion

The experiences gained in this work demonstrate that we need no longer solely depend for fossil evidence of ancestral primates of Tertiary age on geologic stream-laid formations in which such fossils are scattered in small fragments, but that we now have such localities as Baccinello with local concentrations of skeletal parts in more or less articulated condition. Considering the wide regional occurrence of simian horizons in the younger Tertiary of Europe, the quest for primates ancestral or related to man would now seem to have been placed on a geologic basis more secure and more conducive to new evidence for human evolution than ever before. That such encouraging perspectives are now available is due to Hürzeler's studies, and to all those who aided in this first field season, and in particular to the Wenner-Gren Foundation for Anthropological Research, which subsidized this first investigation.

References and Notes

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2. J. Hürzeler, *Schweiz. Palaeontol. Abhandl.* 66, 3 (1949).
3. ———, *Verhandl. Naturforsch. Ges. Basel* 65, 88 (1954).
4. The handicaps caused by conflicting professional duties were partly compensated by the vivid interest of G. Caputo in Florence, the official guardian of antiquities in Tuscany, and by the many helpful aids rendered by C. A. Blanc in Rome. We were very fortunate to find in P. Bertini, a consulting mining engineer of great experience, a man who was full of sympathy with our aims. I am especially grateful also to L. Vonderschmitt, director of the Geological Institute of the University of Basel and acting president of the Geological Commission of Switzerland, and his assistant, L. Hottinger, for their inspection of the crucial field at Baccinello, which resulted in many helpful suggestions. At the coal mine of Ribolla I was greatly aided by Ing. Madotto and his staff of the Montecatini S.A., whose director of mining operations, G. Rostan, lent his good offices for our work.
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8. I am greatly indebted to R. Teichmuller at Krefeld for his offer to have these studies done at that well-known center of coal research.
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