

The Upper Valdarno Basin

A. Azzaroli, nederlandse bewerking K. Steensma
Museo di Geologia e Paleontologia, Firenze

SUMMARY

The Upper Valdarno Basin is famous for its fossils of animals and plants. The history of the basin is complex. Two lacustrine phases can be distinguished, which are partly overlain by fluvial and partly by fan-deposits. These depositional phases range in time from Middle Pliocene to Middle or Late Pleistocene and are separated by phases of non-deposition and erosion. The geological history of the basin, its fossil faunas and their stratigraphical ages are discussed below.

INLEIDING

Het Upper Valdarno bekken is vooral beroemd om zijn zoogdierfossielen van Villafranchische (Midden Pliocene tot Vroeg Pleistocene) ouderdom. Vroeger werd de term Upper Valdarno vaak gebruikt als verzamelnaam voor meerdere vindplaatsen uit dit gebied, waarvan een Laat Villafranchische ouderdom werd aangenomen. Nu weet men, dat de sedimenten in dit bekken een groot tijdsbereik vertegenwoordigen en worden de nieuwe faunas strikt gescheiden beoordeeld (bijv. Castelnuovo, Matassino en Casa Frata).

Belangrijke vondsten uit dit gebied zijn onder andere een incompleet skelet van *Anancus arvernensis*, een schitterende schedel van *Eucladoceros dicranios*, een schedel van *Leptobos etruscus* (het etruskische rund - de soortnaam is afgeleid van Etrurië, het huidige Toskane, waarvan het Upper Valdarno bekken een deel uitmaakt), *Canis arnenensis* (de Arno hond).

Professor Azzaroli van de universiteit van Florence is een autoriteit op het gebied van de faunaontwikkeling in Italië gedurende het Plio-Pleistoceen. Hij is dus bij uitstek geschikt om wat dieper op de problematiek rond het Upper Valdarno bekken in te gaan en een historische beschrijving te geven van deze "bijzondere vindplaats".

SAMENVATTING

Reeds Steno (Nikolaus Stensen) was in de zeventiende eeuw bekend met de geologie en de fossielenrijkdom van het Upper Valdarno bekken. Dit blijkt uit een door hem geschreven boek, de "Prodomus", waarin hij diverse principes van geologische processen verduidelijkt met schetsjes, die gebaseerd zijn op de geologische situatie in dit bekken. Twee van de door hem beschreven principes, vormen de hoekstenen van de stratigrafie (geologische tak, die de ontstaansvolgorde van de aardlagen, de relatieve ouderdom, bestudeert o.a. met behulp van fossielen. Deze principes zijn dat in een bekken de sedimenten in beginsel in horizontale lagen worden afgezet en dat bij een opeenstapeling van die lagen de onderste laag het oudste en de bovenste laag het jongste moet zijn.

De naam Valdarno is afgeleid van Val d'Arno, het dal van de Arno. Het Upper Valdarno Bekken is het stroomopwaarts van Florence gelegen bekken. De geschiedenis van dit bekken is gecompliceerd, wat vroeger niet altijd onderkend werd. Daardoor zijn lange tijd alle fossielen uit dit gebied op een grote hoop gegooid en als één fauna beschouwd. De ontwikkeling van dit bekken is nu goed bekend (fig. 1). Er kunnen twee fasen onderscheiden worden, waarin zich in het bekken een meer vormde (lacustrine fasen). Later gevolgd door een fase met rivierafzettingen (fluviaie fase) in het zuidelijke deel van het bekken en door een fase met puinwaaier-afzettingen (fan fase) in het centrale en noordelijke deel.

Het oudste meer (Lago di Castelnuovo dei Sabbioni) dateert van het Midden Pliocene (Early Villafranchian, Triversa faunal unit (zie fig. 2). De afzettingen leverden plantenresten op, die op een warm gematigd klimaat duiden en een fauna met o.a. tapir (*Tapirus arvernensis*), neushoorn (*Dicerorhinus jeanvireti?*), een rund (*Leptobos stenometopon?*), twee mastodonten (*Mammuth borsoni*, *Anancus arvernensis*) en een beer (*Ursus minimus*).

Uit de hierop volgende periode, die 1 misschien wel 2 miljoen jaar duurde en die correspon74

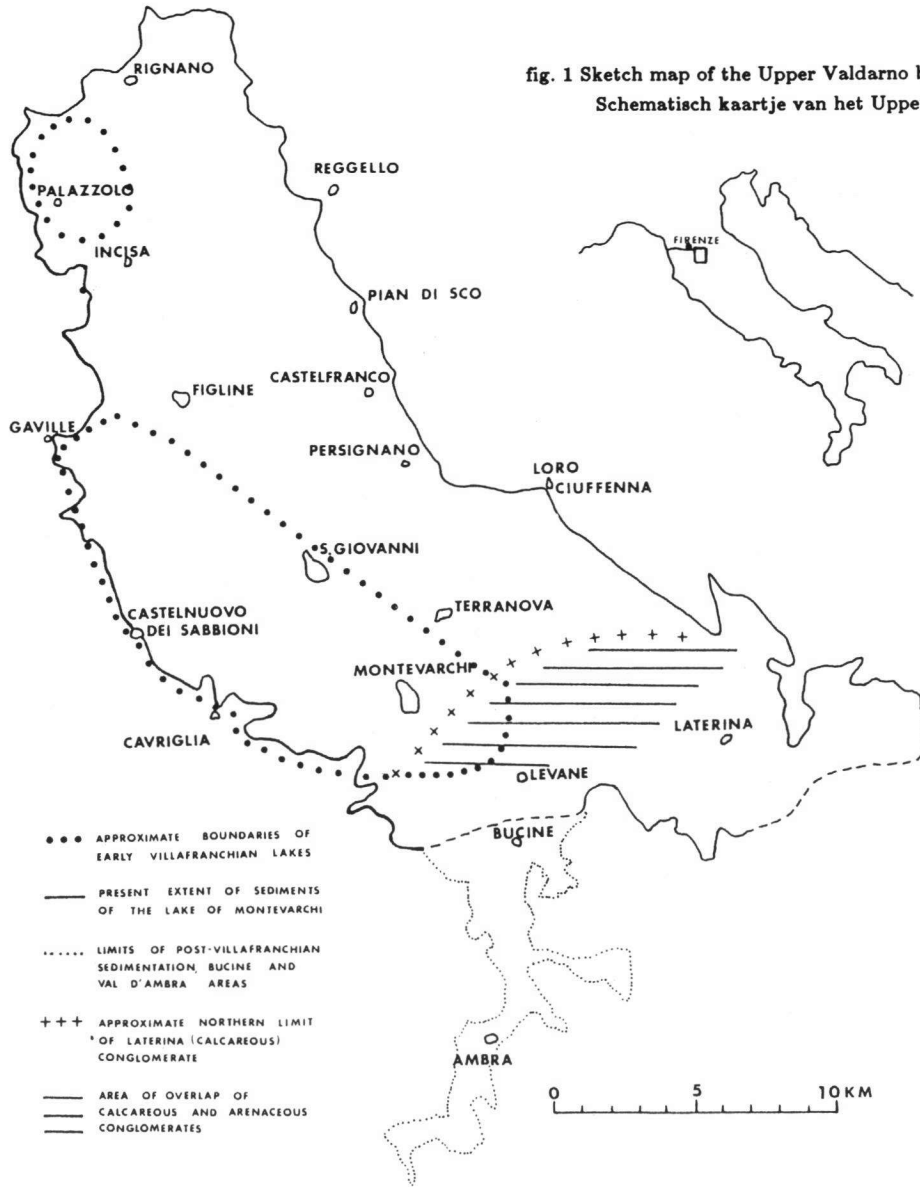


fig. 1 Sketch map of the Upper Valdarno basin.
Schematisch kaartje van het Upper Valdarno bekken.

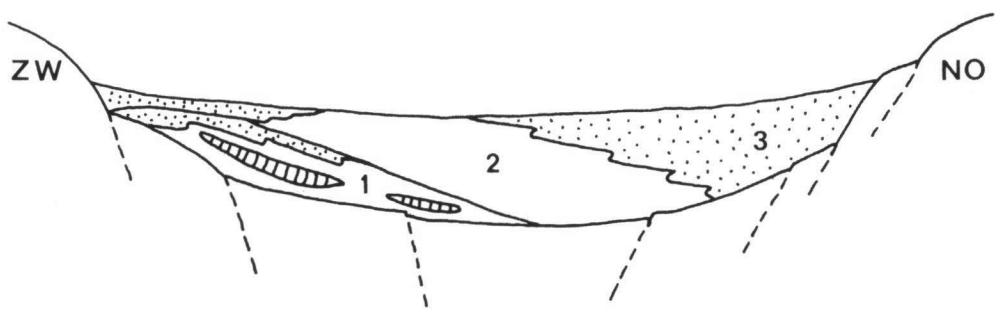


fig. 3 Simplified cross-section of the Upper Valdarno basin from SW (left) to NE. Tilted sediments of the Lago di Castelnuovo dei Sabbioni (1, dashed: lignite) overlain by horizontally bedded sediments of the Lago di Montevarchi (2) and by gravels and conglomerates (3).
Schematisch dwarsprofiel door het Upper Valdarno bekken van ZW (links) naar NO. De scheefstaande sedimenten van het Lago di Castelnuovo dei Sabbioni (1, gestreept: bruinkool), worden bedekt door horizontaal gelaagde sedimenten van het Lago di Montevarchi (2) en door grinden en conglomeraten (3).

deert met de Montopoli en St. Vallier faunal units (zie fig. 2) zijn geen lagen bewaard gebleven, maar wel werden de afzettingen van het meer door bewegingen in de aardkorst scheef gesteld en gedeeltelijk geërodeerd. (zie fig. 3: simplified cross-section)

In het Vroeg Pleistoceen (Laat Villafrancium) vormde zich toen voor de tweede keer een meer, het Lago di Montevarchi. De in deze meerafzettingen gevonden fossielen (o.a. meer dan 30 soorten zoogdieren) duiden erop dat de lagen gedurende een periode van enige honderden duizenden jaren zijn afgezet, wat correspondeert met de Olivola en Tasso faunal units (zie fig. 2). Afgezien van *Anancus arvernensis* is deze fauna totaal verschillend van de voorgaande.

De gesteentes van het Montevarchi meer worden in het zuidelijkste deel, na een afzettingshiaat van enkele honderden duizenden jaren tot misschien wel een miljoen jaar, gevolgd door rivierafzettingen (Gruppo di Monticello) van Midden of Laat Pleistocene ouderdom. In de zanden ("Sabbie di Bucine") en conglomeraten ("conglomerati di Laterina") zijn fossielen gevonden van: *Elephas antiquus*, *Mammuthus primigenius*, *Cervus elaphus*, *Bos primigenius*, *Equus caballus*, *Dicerorhinus hemitoechus* en *Ursus arctos*. Ook zijn er wat vuurstenen werktuigen van het clactonian type gevonden.

In het centrale en noordelijke deel van het bekken werden na de meerafzettingen puinwaaier afzettingen gevormd (grinden, conglomeraten, afgewisseld met zanden) door stroompjes die uit de bergen kwamen (Pratomagno bergketen). Een paar vondsten van *Bison schoetensacki* duiden op een *Galerium* ouderdom (zie fig. 2) voor een deel van de sedimenten, maar de puinwaaierafzettingen gaan door tot in het Laat Pleistoceen.

De geologische geschiedenis van de Upper Valdarno als bekken eindigt met de insnijding van een kloof bij Incisa (betekent letterlijk kloof, spleet) waardoor de waterhuishouding drastisch veranderde.

P L I O C E N E		P L E I S T O C E N E		Radiometric or na- laeomagnetic dates	Upper Valdarno local faunas	
Middle	Late	Early	Middle			
V I L L A F R A N C I A N	Early	"MASPINIAN"		0.12	Maspino Bucine	
				0.4		
	Middle		Ranuccio		Casa Frata Matassino	
			Süssenborn			
	Late		transitional faunas			0.9
			Farneta			
			Tasso			
			Olivola			
			S.Vallier	1.8		
	Early		Montopoli	2.5		
Triversa		3.0	Castelnuovo dei Sabbioni			

fig. 2 Chronostratigraphy of the Plio-, Pleistocene with e.g. faunal units and local faunas of Upper Valdarno.

Chronostratigrafische kolom met de indeling van het Midden Pliocene tot het Laat Pleistoceen, de fauna-eenheden, absolute ouderdommen en enkele lokale fauna's.

Nikolaus Stensen is universally acknowledged as the author who laid down the principles of geological chronology. Stensen (often latinized as Steno) was in fact the first to conceive the Earth as a body involved in a steady process of transformation: orogeny, erosion, sedimentation ... as opposed to the static conception of his predecessors and contemporaries, who saw the Earth as an immutable planet, fixed in its present condition since the beginning of times. The fundamental concepts of geological processes, origins of minerals and fossils etc. were exposed in a small book with the rather obscure title: "De solido intra solidum naturaliter contento dissertationis prodromus", usually more briefly referred to as the "Prodromus". This name implies the publication of a wider treatise, which however was never written. The expression "De solido intra solidum naturaliter contento" is related to Stensen's primary concern to explain the origins of minerals and especially of fossils contained inside solid rocks: they are objects that were enclosed in sediments that were once loose particles of sand, or clay, or lime and were later lithified. Stensen was clear on the principles of stratigraphy: sediments were laid down as horizontal beds formed by accumulation of originally incompetent matter and occupied the whole extent of the sedimentary basin. Beds which appear truncated in a cliff have been modelled in their present shape by erosion, and in a sequence of superimposed beds the lowermost one is necessarily the oldest, the topmost one the youngest. But Stensen also remarked that the Earth is not at rest. Beds which were originally horizontal may be tilted and displaced, then covered by younger beds lay down horizontally, in angular unconformity; this unconformity represents a chronological gap between the older and the younger set of sediments. These ideas were illustrated in a series of small sketches accompanying the Prodromus.

Characteristically these sketches reflect the situation of the Upper Valdarno basin, which was already renowned in the seventeenth century because of its riches of fossils of animals and plants, and had therefore attracted Stensen's attention.

The current name Valdarno is actually a contraction of the more correct expression Val d'Arno (valley of the Arno) and is generally used by non-geologists to designate the large basin that extends upstream of Florence over more than 30 km., from Rignano

and Sant' Ellero to the North as far as Larterina to the South East. Actually however, Valdarno means only the valley of the Arno and in the geological literature this name has been used in a broader sense. Geologists distinguish a "Valdarno Superiore" (Upper Valdarno), so called because it lays upstream of Florence, and a "Valdarno Inferiore" (Lower Valdarno), a marine and lagoonal basin which extends downstream of Florence, from Montelupo and Capraia to the Tyrrhenian coast. The Lower Valdarno is also rich in fossils, marine, brackish and continental, but its faunas are different from those of the Upper Valdarno. Another lacustrine basin, occupied by the large towns of Florence, Prato and Pistoia, lies between the Upper and the Lower Valdarno.

The Upper Valdarno is an basin elongated from North North West to South South East, closed between Oligocene to early Miocene turbiditic greywackes, "Macigno del Chianti", which form the Chianti range to the West, with average elevations between 700 and 850 m., and the Pratomagno range to the East, with elevations from 1500 to nearly 1600 m. The history of the basin is complex and this complexity is reflected in its fossil content. This fundamental fact was long overlooked by Italian geologists of the last century and of the first quarter of our century, a mistake that still lingers in some works of non-Italian geologists and palaeontologists of our days.

There were two lacustrine phases. The older lake (Lago di Castelnuovo dei Sabbioni) dates from the Middle Pliocene (early Villafranchian, Triversa faunal unit). It was rather small, less than 10 km from North East to South East. Its sediments are regularly bedded clays ("Argille di Meleto") with frequent phyllites and with thick lignite seams at their base, covered more or less conformably by bedded sands, whitish to light-yellow in colour ("Sabbie di San Donato in Avane"). They are exposed in the left (West) bank of the basin and are all more or less strongly tilted, with prevalent dips to the North East. The clays contain a rich flora typical of a warm temperate climate (*Pinus*, *Sequoia*, *Taxodium*, *Glyptostrobus*, *Magnolia*, *Platanus*, *Liquidambar*, *Juglans*, *Quercus* etc.); the fauna is less rich and is represented by freshwater molluses and by vertebrates: tench, terrapin, tapir (*Tapirus arvernensis*), rhino (*Dicerorhinus jeanvireti*), a large bovid (*Lepitobos stenometopon*), two mastodonts (*Mam*

mut borsoni, *Anancus arvernensis*) and a bear (*Ursus minimus*). Vertebrates come from the lignite bearing clays and are generally poorly preserved but a skeleton of *Ursus minimus* is the finest representative of its species. An incomplete skeleton of *Anancus arvernensis*, collected and described in 1826 by Filippo Nesto, may possibly come from the sands of San Donato in Avane.

The sediments of the lake of Castelnuovo dei Dabbioni plunge eastward and disappear under the deposits of the lake of Montevarchi. An angular unconformity, corresponding to a gap of over 1 my and possibly even spanning 2 my separates the two lakes. During the Montevarchi lacustrine phase the basin expanded considerably to the N and to the SE. The lake of Montevarchi is also represented by clays and sandy clays overlain by sands and silts. Bedding is practically horizontal throughout the basin and is more irregular than in the older lake; cross-bedding and erosion channels are common features, sands are more or less rich in clay and clays are more or less sandy. The series may be termed fluvio-lacustrine rather than frankly lacustrine. Exposed thicknesses vary between 80 and 100 m but a much greater thickness of sediments is buried in depth. Plant remains are scanty and poorly preserved but the vertebrate fauna is very rich: tortoise, several birds and over 30 species of mammals: primates, proboscideans, rodents, carnivores, perissodactyls, artiodactyls. The fauna was retrieved from the clays and from overlying sands and silts. It is characteristic of the Early Pleistocene (Late Villafranchian) but is not chronologically uniform. In fact it straddles the Olivola and Tasso faunal units and recent collections, with good stratigraphic control, have given evidence of a definite faunal enrichment from the lowest beds (about 160 to 190 m a.s.l.) to the youngest (200 to 220, occasionally 230 m a.s.l.). The time interval involved is of the order of some hundred thousand years. The fauna of the lake of Montevarchi is totally different from the fauna of Castelnuovo dei Sabbioni, with the only exception of *Anancus arvernensis*, recorded from the lowermost levels of the younger lake, and is totally extinct.

There is a time gap of at least 1 my and possibly of as much as 2 my separating the faunas of the lakes of Castelnuovo dei Sabbioni and of Montevarchi.

The lake of Montevarchi is overlain in its turn by fluvial calcareous gravels, sands

and silts in its southernmost area ("Gruppo di Monticello").

The fluvial sands ("Sabbie di Bùcine") and the underlying gravels ("Conglomerati di Laterina") yielded a rich fauna of Middle or Late Pleistocene vertebrates: *Elephas antiquus*, *Mammuthus primigenius*, *Cervus elaphus*, *Bos primigenius*, *Equus caballus*, *Dicerorhinus hemitoechus*, *Ursus arctos*, and the gravels also a small amount of flint implements of Clactonian type. In spite of an apparent conformity, the time gap between the sediments of the lake of Montevarchi and the Monticello group is of the order of several hundred thousand years, possibly even one million years.

The postvillafranchian history of the central and northern parts of the basin was different. Here the lacustrine sands grade upwards into fan deposits laid down by streams descending from the Pratomagno range and consisting of coarse arenaceous gravels and conglomerates alternating with sands. Few remains of *Bison schoetensacki* date a part of these sands and gravels to the Galerian, but fan deposition continued well into the late Pleistocene and in some outcrops North of Laterina the arenaceous gravels overlie the calcareous Laterina gravels. Acheulean implements were reported from surface deposits on the fans.

The sedimentary history of the basin came to an end with the downcutting of the gorge at Incisa (literally "the Cleft"), excavated in the pre-lacustrine bedrocks. The Upper Valdarno basin, which originally seems to have discharged to the South, was now captured in the direction of Florence by the lower section of the Arno and the whole lacustrine and fluvial basin fell prey to erosion, which has exposed the fossiliferous rocks.

The geological vicissitudes of the Upper Valdarno basin find expression in the varieties of its faunas. The fauna of the lake of Castelnuovo dei Sabbioni may be referred to the Triversa faunal unit of AZZAROLI (1977): the occurrence of *Leptobos*, although of doubtful specific identity, and of *Ursus minimus* rule out a Ruscinian age, while *Mammuth borsoni* and *Tapirus arvernensis* define an age older than the great faunal revolution of approximately 2.5 my ("Elephant-Equus event", Lindsay et al. 1980). The time gap between the lakes of Castelnuovo dei Sabbioni and of Montevarchi corresponds in the mammalian time scale to the Montopoli and Saint Vallier units; the faunas of the lake of

Montevarchi straddle the Olivola and Tasso units, while some teeth of an equid with rather progressive features collected near Bùcine may perhaps represent a very late phase of the late Villafranchian, although this is uncertain (Azzaroli, 1984). The Galerian time interval is represented by few remains of *Bison schoetensacki*; sedimentation was still active at this time in the basin. The Laterina gravels and the Bùcine sands may be dated to the latest part of the Middle Pleistocene or to the beginning of the Late Pleistocene: the fauna offers no clues for a more precise dating and the Clactonian flakes are clearly reworked. The Laternia gravels are also interesting as

they witness a new stage in the evolution of the complicated drainage pattern of the Arno: they were derived from the uppermost section of the river, the Casentino district: another lacustrine, vertebrate bearing basin. The tortuous course of the upper Arno, with its great bend near Arezzo, had formed at this time. The capture of the upper Arno by its present middle (Florence) and lower sections took place in two steps. First, the Florence basin (another late Villafranchian lake, with *Archidiskodon meridionalis* etc.) was captured by downcutting of the Gonfolina gorge and began to drain to the W; then erosion proceeded upstream until the capture of the Upper Valdarno at Incisa.

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adres auteur:

Prof. A. Azzaroli
Museo di Geologia e Paleontologia
Via G. La Pira, 4
50212 Firenze (Italy)

fig. 4 Lignite mine at Tegolaia (Lago di Castelnuovo dei Sabbioni): Lignite seams dipping NE overlain by bedded clays ("Argille di Meleto"). Note a recumbent tree trunk (left) and a standing tree stump (above the lorry, to the right). This mine is now buried under the dumps of the large openair excavation of the Santa Barbara mine.

Bruinkoolmijn bij Tegolaia (Lago di Castelnuovo dei Sabbioni): de bruinkoollagen hellen naar het noordoosten en worden bedekt door gelaagde kleien ("Argille di Meleto"). [links op de foto is een omgevalen boomstronk te zien en net boven de vrachtauto, aan de rechterkant, een rechtopstaande boomstronk]. Deze mijn is nu begraven onder de afvalhopen van de grote openlucht afgraving van de Santa Barbara mijn.

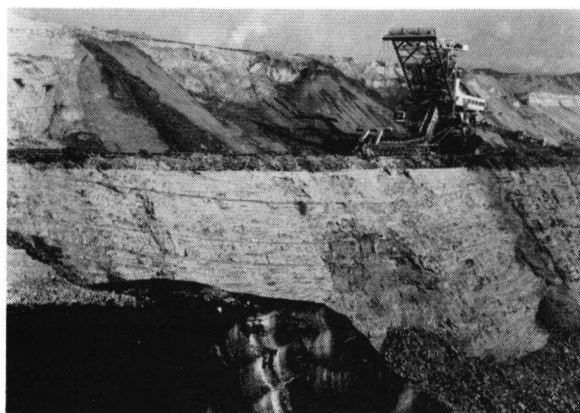
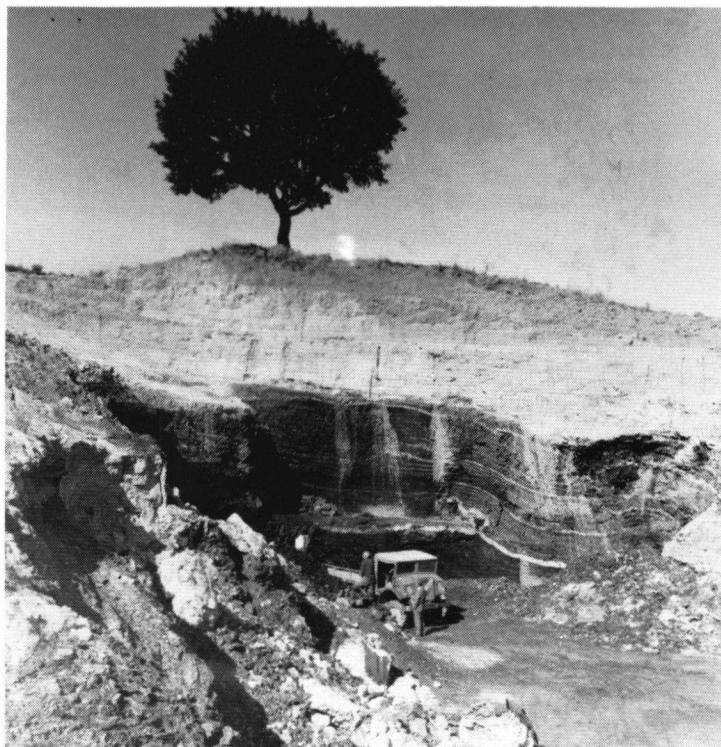


fig. 5 A view of the open-air excavations of the Santa Barbara lignite mine (Lago di Castelnuovo dei Sabbioni). Clays ("Argille di Meleto") are removed and the lignite seams are laid bare for exploitation.

Een blik op de dagbouw van de Santa Barbara bruinkoolmijn (Lago di Castelnuovo dei Sabbioni). De kleien ("Argille di Meleto") worden verwijderd, waardoor de bruinkoollagen blootgelegd worden voor exploitatie.

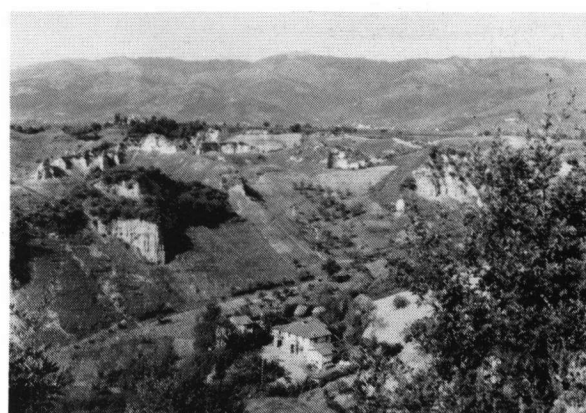


fig. 6 A view of the deposits of the Montevarchi lake, looking NE; in the background the Pratomagno range. Badland morphology of eroded sands and arenaceous gravels overlying fossil bearing silts and clays (lower parts of the slopes). Note horizontal bedding.

Een blik op de sedimenten van het Montevarchi meer, kijkend naar het noordoosten; op de achtergrond de Pratomagno bergketen. Landschap met sterk geerodeerde zanden en sandhoudende conglomeraten, die liggen op fossielhoudende silten en kleien (de lagere gedeeltes van de hellingen). Let op de horizontale gelaagdheid.

fig. 7 A fine skeleton of *Ursus minimus* (= *U. arvernensis*) from an old lignite mine at Gaville (Lago di Castelnuovo dei Sabbioni). Museum of Florence.

Een skelet van *Ursus minimus* (= *U. arvernensis*) uit een oude bruinkoolmijn bij Gaville (Lago di Castelnuovo dei Sabbioni). Museum van Florence.

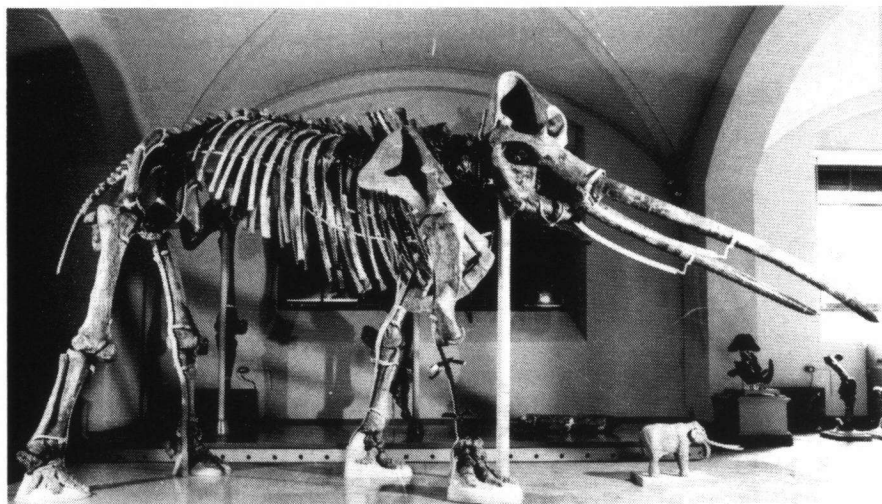
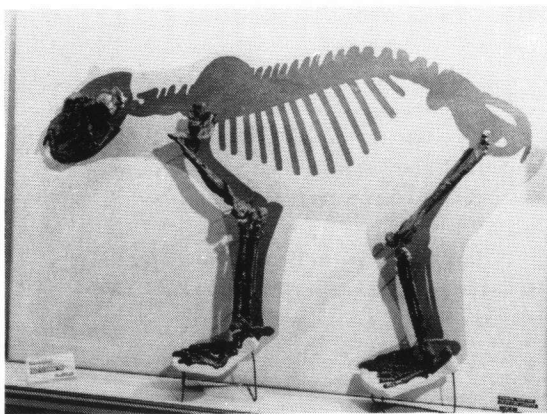
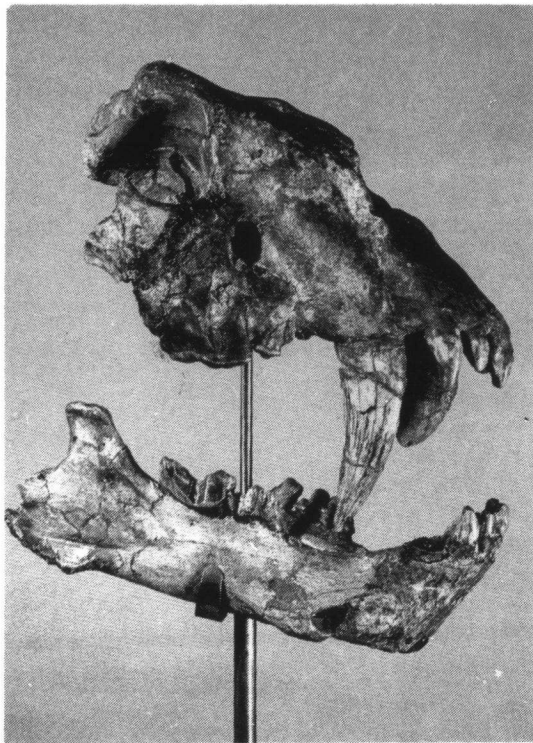


fig. 8 Skeleton of *Anancus arvernensis* collected in 1826 by Filippo Nesti near Montecarlo, Upper Valdarno; probably from the sands of San Donato in Avane, Lago di Castelnuovo dei Sabbioni.

Skelet van *Anancus arvernensis* verzameld door Filippo Nesti in 1826 in de buurt van Montecarlo, Upper Valdarno; waarschijnlijk uit de zanden van San donato in Avane, Lago di Castelnuovo dei Sabbioni.

fig. 9 Skull of *Homotherium crenatidens*. Upper Valdarno, Lago di Montevarchi.

Schedel van *Homotherium crenatidens*. Upper Valdarno, Lago di Montevarchi.



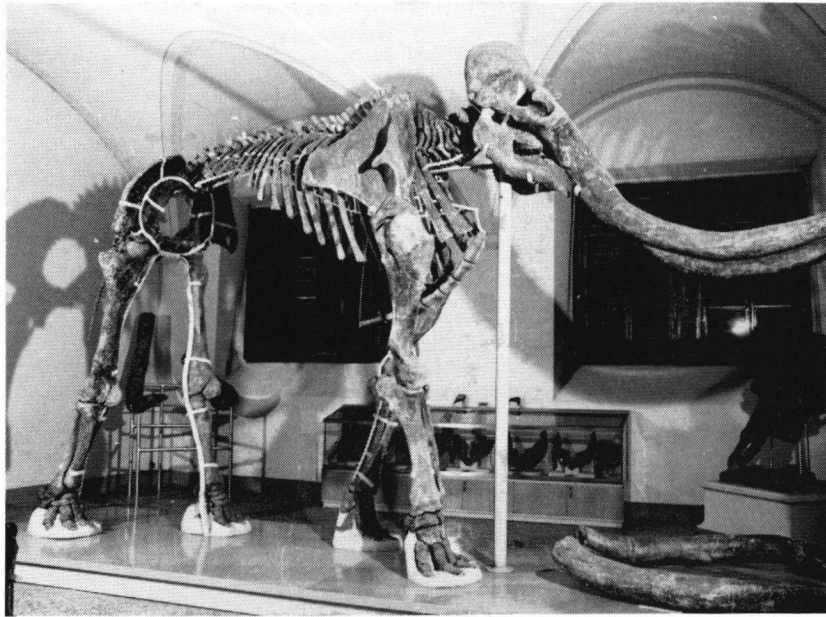


fig. 10 Skeleton of *Archidiskodon meridionalis meridionalis* collected in 1953 at Borro al Quercio, Valdarno Superiore (Lago di Montevarchi).

Skelet van *Archidiskodon meridionalis meridionalis* verzameld in 1953 bij Borro al Quercio, Valdarno Superiore (Lago di Montevarchi).



fig. 11 Skull of *Eucladoceros dicranios* collected near Figline and described by Filippo Nesti in 1841. Lago di Montevarchi. Antler span 190cm.

Schedel van *Eucladoceros dicranios* verzameld bij Figline en beschreven door Filippo Nesti in 1841. Lago di Montevarchi. Spanwijdte van het gewei 190 cm.