English translation of five of Scarabelli's articles relevant to the origin of prehistorical archaeology (1846–1852)

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Foreword

Five early Scarabelli's articles written in Italian, reporting on fossil bones and associated stony implements from the Imola Quaternary alluvial deposits and spanning the time interval 1846 to 1852, have been mostly ignored in the international literature for many reasons, especially language. Those years were critical to the origin of prehistoric archaeology in Europe. I felt useful to translate them in English and publish online to back up a paper on this matter I have almost ready for publication.

The translation, as literal as possible, was revised by Frances Westall, to whom I am deeply indebted. The articles are listed as numbered appendixes to the paper.

Appendix 1

A word about fossil bones in the Imolese area [*Una parola sulle ossa fossili dell'Imolese*]

By G. Scarabelli

Nuovi Annali delle Scienze Naturali di Bologna, Agosto 1846, (2), 6, 81–84, 1846.

Since its first appearance in space, the planet we are living on has been punctuated by many different catastrophes. One of the latest and most well documented was one that totally destroyed or displaced many species of large quadrupeds. Given their abundant remains, the latter should rightly be regarded as former peaceful inhabitants of these regions. Untrained people wonder at the huge tusks, the gigantic whole jaws, the enormous femurs. Once upon a time unbelievers and malicious people referred to them as Nature's jokes rather than recognising them as the remains of ancient creatures.

Let us laud the Italians who first pleaded for the truth, and had to overcome the stubborn opinion of their time [1]. They led the foundations of a science that was then unknown but has now come into its own through the labours of the immortal Cuvier, and [*p. 1 / 81*] many others of his time and later. He ably taught how to detect and represent epochs and formations from around the Globe, each one of which was

[1] Lyell in his *Principes de Géologie*, Paris 1845, p. 62, mentioning Steno's work *De solido intra solidum naturaliter contento* says: This work attests the priority of the Italian school in the geological researches and points out at the same time the powerful obstacles opposed in that century to the general acceptance of ideas able to favor the progress of Science.

characterised by a single living form that was special and totally exclusive for it [1]. Such great and even greater truths will be widely confirmed so long as we abstain from preconceptions limit our self to the simple observation of facts. Thus [great truths] will be reserved to those who knew well to investigate nature's works.

This noble aim led to continuous and also stubborn searches by my townsman Mr. Giuseppe Cerchiari in these hills close to Imola. He successfully acquired an abundant collection of fossil bones that is of general interest for natural scientists and brings prestige to our City. For this reason, I will now briefly report the catalogue of bones owned by Cerchiari in order to pay him tribute and bring back to memory the Geologist's glimpse of such pleasant places.

I will attempt to provide details of the nature of the soil where the bones are buried, as well as their position on the series of terrains in another paper, as I am prevented from doing this now owing to family matters.

Catalogue of the Fossil Bones in the Imola area

Animal	No.	Bone name	Finding locality	Remarks on	
				Bones	Setting
Elephas	1 2 3 4 5 6-12	Portion of Tibia Same upper Tibia Kneecap Tarsus Metatarsus fragments Bones to be determined	Bergullo Creek 1843	All parts of the same individual	Found in quartz-calcareous Sand containing marine shells
E. primigenius	13 14 15	Two Molars Parts of two Molars Part of Molar	Pratella Creek		Sand as above
Elephas	16 17	Part of Molar not yet out of socket Middle part of Tusk	Gonze Valley 1838	Ø 10-22 cm	
Rhinoceros	18 19 20	Part of Jaw	Bergullo Creek 1841 Pratella Creek 1844 Gonze Creek		
Hyppopotamus	21 22 23	Upper Molar upon part of jaw Upper part of Tusk Middle part of Tusk	Pratella Creek 1841 Gonze Creek		Found in the uppermost bed of subapennine marl

[1] This science whose name indicates the study of ancient beings (palaids and ontos) is concerned with the history of fossils and its main aim is to know the forms and the zoological relation of beings that lived in the globe in different epochs before our. It has to fill also one of the most remarkable pages of earth history, restoring the successive phases of organization of animal life on the earth "Pictet, *Traité Elémentaire de Paléontologie*, Paris 1844, p. 23."

Horse	24 25	Part of Metatarsus Four Molar teeth	Pratella Creek		
Ruminants	26 27 28 29 30 31 32 33-35	Some molars Unidentified bone Upper part of Deer horn 2 fragments ?Radio bone large ind. Fragment of Deer horn Parts of 2 Deer molars Fragment of jaw Undetermined bones and teeth of recent finding	? ? Castellaccio Pratella Creek Santerno [River] Pratella Creek Goccianello Creek Pratella Creek	Mean ø 6 cm	Inside a shell-rich sandy calcareous pebble Water transported
Bird	36	Distal part of homer[1]	Pratella Creek		

Appendix 2

Catalogue, Fossil bones discovered in the surrounding of Imola, in Romagna

By Mr. [Giuseppe] Scarabelli

In: Letter to the President of Société Géologique de France

By [Antonio] Toschi

Bulletin de la Société Géologique de France, (2), 3, 440–442, Paris, 1846.

The Vice Secretary reads the following letter by Mr. Toschi [fellow of the Société Géologique de France **with a contribution by Mr. Scarabelli**]:

Mister President,

Allow me to address a catalogue of some fossil fragments of animals discovered numerous times in the subapennine terrain surrounding Imola in Romagna for you to present to the Society that you so worthily preside and of which I am honoured to be a member. My only objective is to increase the number of materials available to serve learned people engaged in natural sciences in a complete and general approach.

You will permit me to take this opportunity of making you acquainted with the catalogue which is a recent work by Mr. Scarabelli, who owns some of these fossils and who is much engaged in the geology of his country. The catalogue lists, among others, an elephant tusk which, for its deposit, state and also size, is in a condition fully similar to the tusk described by Mr. Prémorel in *Bull. de la Soc. géol.,* 1839-40, p. 165, and said to have been discovered by him at Differdange.

[1] This bone and many others were determined by Prof. Alessandrini, who accepted very kindly.

All these different fossils were hidden inside the same terrain, although distributed in strata of different levels; this terrain, whose composition is given in the same catalogue, shows surprising stratigraphic conformity with the subapennine marls upon which it lies. Moreover, the presence of marine shells of characteristic species that are always present with the bones suggest that this terrain is an [upward] extension of the Pliocene terrain which, towards the plain, is buried beneath the diluvian [terrain] and in which some erratic boulders are starting to be recognised.

The extent of the area in which these bones occur is not very large, compared with what one would consider to be the surroundings of a city. In fact, fossils are only found in the southern part of the city [Imola] on the further bank of the Santerno river, which confines the last extension of the hills that gradually descend from the Apennines to the great plain of Romagna in this locality. The four streams from which the bones were excavated, as shown in the catalogue, merge into the Santerno river. This is the reason why a fragment of deer horn was found in this river.

In the hope of providing science with something of great interest, this research will be pursued with even more enthusiasm if the Society is willing to indulge the modest work that I am sending you, Mr. President, with the highest esteem and respect.

Fossil bones discovered in the surrounding of Imola, in Romagna

Animal	No.	Bone name	Locality & date	Remarks
	1	Par t of tibia		All bones of the same individual dug from shell-rich quartz calcareous sand
	2	Upper femoral part of tibia		
	3	Kneecap	Bergullo Creek 1843	
	4	Metatarsus fragments		
	5	Tarsus bone		
	6-12	Bones to be determined		
	13	2 molar teeth		Same individual ? Quartz calcareous terrain
	14	Part of 2 molars	Pratella Creek	
	15	Part of another molar		
	16	Part of molar not yet out of socket	Grazie Valley 1838	In same sand: Ø 10-22 cm
	17	Middle part of tusk	Pratella Creek	
	18	Part of jaw	Bergullo Creek 1841	
	19	12 molars of upper jaws	Pratella Creek 1844	Same sand
	20	Part of jaw ?	Grazie Creek	
	21 .	A molar in his jaw & fragment of another detached tooth	Pratella Creek 1841 .	Latest bed of subapennine blue marl
	22	Apical part of a canine tooth	Grazie Creek 1841	
	23	Middle part of a canine tooth		
	24	Part of metatarsus	Pratella Creek	
	25	4 molars	?	

	26	Different molars		
	27	Undetermined bone		
	28	Lower part of a horn	Castellaccio Mount	Same sand
	29	2 ?radius fragments	Pratella Creek	
	30	Horn fragment	Santerno River	Mean ø 6 cm
	31	Parts of 2 molars		
	32	Fragment of a jaw	Goccianello Creek	
	33	Distal part of homer	Pratella Creek	Same sand
	34-36	Undetermined bones and teeth of recent finding not yet determined		Same quartz calcareous sand

Appendix 3

About the deposits of fossil bones existing in the Imolese (Letter of Giuseppe Scarabelli to Antonio Toschi) [*Sui depositi delle ossa fossili esistenti nell'Imolese. (Lettera del ch. Sig. prof. Giuseppe Scarabelli al ch. Sig. prof. Antonio Toschi)*]

Nuovi Annali delle Scienze Naturali di Bologna, (2), 10, 297–302, 1849.

Dearest Friend

You ask me in your letter whether I ever did pay back the small debt that I owed scholars of nature when I published a barren catalogue of Fossil bones in the Imola area in the *Annali delle Scienze Naturali di Bologna* (August 1846 issue). I had promised to reveal to them the both the [stratigraphic] setting and the epoch of their deposit in another paper. Now, I frankly answer that I did not do so for the good apology that much more difficult engagements prevented me from doing so.

However, I will not refrain from satisfy your desire because you are the one, among the worshipers of Natural Sciences for whom both the tie of long friendship as well as being able to forgive a short report, can supply with his own past observations in the surroundings. For better clarity, I will use a small illustration from my geological field notes.

First of all I am stating to you that, after much experience shows, it seems that the fossil Bones of our country are only found in the series of small hills, which are the furthest extension of the Subapennine Hills and are confined on one side by the Santerno River and on the other side by the Bergullo Stream. Such a restriction of the bone-rich terrain could actually be apparent because of the lack of such fossils in similar conditions elsewhere [*p. 298*]. However, it seemed to me that I recognised some particular features where the Fossil Bones are present and none where they are lacking. Thus, the distribution of Fossil Bones in our hills has to be related to limited and restricted causes, rather than to general causes acting simultaneously over a large area, as currently believed. As is well known, our hills have a shell-bearing blue clay at their base, which has a flat stratification or dips gently towards the plain, as is the case for all other hills in this country. A few light beds follow just above the blue clay, to which they show certain similarities in their clay nature, but which have the same colour and sandy nature of the overlying beds. Thus, from a mineralogical point of view, these strata are blue sandy clays that represent a gradual transition from the Subappenine clay to the well-known shell-bearing yellow sand. Vertebrate bones were found in this latter terrain for the

first time, including an upper molar Rhinoceros tooth (Pratella Stream). As a matter of fact, the yellow sand is not always and exclusively followed by sandy clay in our bone-rich hills, in particular where the most fossils are found (Sganga Hill). You will find that it is replaced by a thick layer of Calcareous Conglomerate (*Puddinga*) with some marine shell fragments, common plants, as well as Vertebrate remains. The conglomerate is composed mostly of the various limestones that are abundant in our Apennines and contains also many grits and chert pebbles.

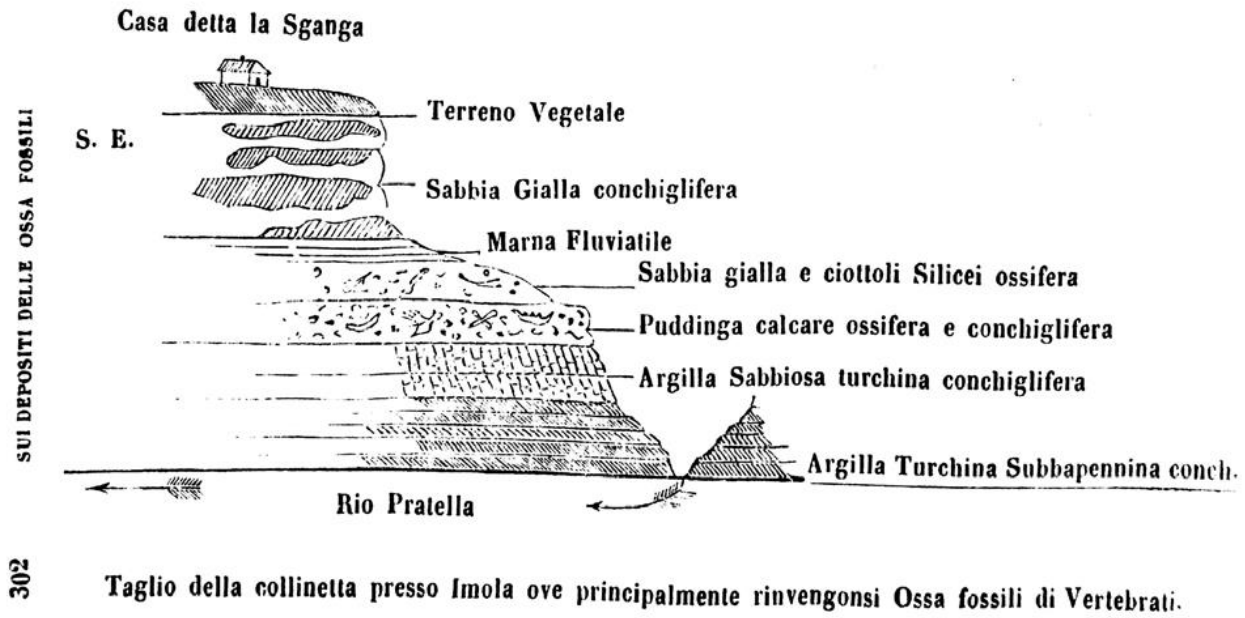
The cement binding these components and the various fossils is formed by a coarse [grained], yellowish limestone mixed with abundant sand also filling the voids between the pebbles. Elsewhere (at the Castellaccio [*p. 299*] Mount and the so-called Lastre of the Santerno [River]) this same conglomerate appears as a coarse [grained], rather consolidated sandstone owing to the decreasing size of its components. Also, in this sandy state, it has delivered some bone fragments welded into the sandstone together with more frequent and unbroken marine shells. On the other hand, beneath the parish church of Bergullo, close to the well-known Mud Volcanoes, the same pebbly components of the afore-mentioned conglomerate are almost all disrupted and loosened to form a friable deposit of gravel. I do not know if it is possible to be sure that some bones collected in the surroundings were derived from exactly that location but it is quite probable. When speaking about this gravel it is worth noting to mention the great abundance of siliceous pebbles that are comprised almost completely of Nummulites. Our colleague Professor *Collegno*, whom I took to the location, did find this observation worthy of the attention Geologists in general. Its importance was proven when I told him that this occurred in many other places. We also agreed that, to date, Nummulites had not been found in cherts in our Apennine [mountains] (from which those pebbles were certainly derived). It is necessary also for you to know that similar Siliceous nummulite-rich samples have been observed by *Cortesi* in the Parma area. This Author declared in his Geological Essays that the Nummulites had been formed in the chert by the particular crystallisation of some mineral substance!!! Coming back to the point, a purely local admixture separates the Sandy Clay from the true Yellow Sand in the hill drawn in the attached figure. These pebbles, which are no larger than a hazelnut or an almond [*p. 300*], are sometimes very attractive aspect and not unfrequently reveal agates and carnelians to the naturalist digger. One finds here also bones and very rare shell fragments. A rather weak, 2 m thick yellowish marly shale follows, which contains some imprints of leaves pertaining to terrestrial plants still living in this surroundings, and a few rare but quite characteristic fresh-water shell remains. Above this [layer], still at the Sganga [locality], we finally meet the well-known yellow sand, which often shows consolidated layers in the form of fragile molasse and presents only some species of Ostreids, Dentalids, Serpulids, and pectinids as characteristic fossils. This deposit is about 15 m thick and it appears to be bedded only in large outcrops. As you can see, this [deposit] conformably follows the blue marls and, with respect to the fossils and mineralogical transition, is of the same epoch [as the blue marl], representing its latest period. However, the [yellow sand] differs from the [blue clay] for its negative character (scarcity of fossils, faint bedding). Therefore, I am obliged to assign its origin to the continued action of the sea and the winds producing very high dunes, or at least wide elevated beaches, which are all sandy and uneven, as seen today along the coast of many seas. A few bones have been found in this sand, although I am afraid that collectors may have been mistaken because of its dispersal [by erosion]. However, if these findings were not to be proven, it would not change much my opinion about the causes transporting the Vertebrate bones in our hills.

I mentioned to you the local, not very wide deposits (listed from bottom to top): Calcareous Conglomerate, sand and siliceous pebbles, Fluvial Marls. Summarizing, I believe that these three members represent the material transported by a large river descending our Apennines and debouching into the Pliocene sea. Naturally, it transported the remains of the animals living in its surroundings that it encountered along its course. If this is true, I could very well explain how, close to the sandy clay depositing at the bottom of the Pliocene sea, later on layers of yellow sand formed on the beach in all those places where intermediate deposits [between sand and clay] could not form because of the lack of [rivers] flowing into the sea. In this

way, once the river had abandoned its bed for whatever reason, the sea, maintaining its previous height continued to spread the same yellow sand that it had laid down and accumulated elsewhere over the abandoned river bed. In more recent times, this river wandered within certain limits and incised the upper part of the Yellow sand (at the Castellaccio Mount on the road leading to Villa Baladelli) when the sea occupied its present level. There the river brought [pebbles] which it could not [deposit] during its ancient courses, [i.e.] Ophiolitic rocks, Jaspers, Spilites (that had not yet appeared on the Apennine [erosional surface]). A deposit of the *Diluvial Epoch* originated [from these rocks]. Eventually, at the present day, this water course became much smaller because of the formation of many denudation Valleys in between and is now called Santerno. Those living nearby know well how it transports material characterising the *Present Epoch* [called also Anthropic in Scarabelli's geological maps of those years] to the sea, which then accumulates there.

Imola February 5 1849

Yours Friend and Colleague Giuseppe Scarabelli



Geological section along the Pratella Creek with detailed stratigraphical column of the clastic deposits with fossil bones and cherty pebbles outcropping at the house called *la Sganga* in the Imola area (*p. 302*). From bottom: Cutting across the hill near Imola where most of the Vertebrate fossil Bones are found. Shell-bearing Subapennine Blue Clay. Shell-bearing blue Sandy Clay. Shell- and bone-bearing calcareous Conglomerate. Yellow Sand and bone-bearing cherty pebbles. Fluvial Marl. Shell-bearing Yellow Sand. Vegetated Terrain. House called *la Sganga*.

Appendix 4

About the ancient weapons of hard stone collected in the Imolese area [*Intorno alle armi antiche di pietra dura che sono state raccolte nell'Imolese*]

Note by Giuseppe Scarabelli G.F.

Nuovi Annali delle Scienze Naturali di Bologna, fasc. di Settembre e Ottobre 1850, (3), 2, 258–266, 1850.

It is not new for Naturalists to find certain types of hard stones shaped by human hand, such as arrow Darts, Axes, and Wedges hidden in Terrains of the *Present or Modern Epoch*. The books of Mineralogy tell us that such discoveries are common in different parts of the Globe. When describing species of Flint, Serpentine, Nefrite, Chert, almost all [books] mention that such mineral species were used by the Ancients, and also by some people today, who do not know the use of metals, for manufacturing weapons for defense or domestic tools. Such weapons are strictly related to History of Nations. Thus, both the Antiquarian and the Historian take them for their very interesting studies for evaluating the various degrees of civilization they had reached (and even today in some modern Nations) with respect to their origin, migration, mixing, and [*p. 4 / 259*] customs. Mr. Jouannet took opportunity to write a well-documented memoir based on weapons of this type found in France near Perigneux (the ancient Vesunna) in the Annals of the Dordogne Department, Year 1819. He believes they were used by the ancient Gauls, and calls them Gallic Weapons. Mr. Brard speaking about the uses of the Flintstones in his work *Mineralogie Appliqué aux arts*, says that they are used even today for defense by natives of the Friends Islands and other Islands in the South Sea. Similarly, in the *Voyage autour du monde* Arago speaks about the stony weapons held by the fierce natives of New Zealand. They use them with high skill and very often sadly to carry acts of unprecedented barbarism against their own kind.

It is not my aim to enter into the very large field of these speculations. For instance, Historians consider that Weapons, known for being made of the same material and for having a characteristic form, are found scattered all over the Globe at huge distances from each other, separated by great seas, and owned by Peoples who once dwelled Europe and by those still isolated in Oceania; actually, who can dares to question who among these two peoples was the first to implement the weapons? In which way, and at which time were weapons introduced to us, or transported to them? Or was their creation common to both, related to an equal need of life, and produced by a similar development in their intellectual capacity? To me it is not easy to join the many who have researched such great topics: I shall limit myself to the information that a wealth of these weapons have been found also in our Italy, close to Imola. Their major [*p. 5 / 260*] or minor state of perfection of fabrication and their various forms can be observed in the attached Plate. I wish to express the thoughts derived from their setting in our hills and the diversity of mineral species in which they are formed in relation to the petrology of our Country in this short Note.

The largest collection of Weapons that I am speaking about, including also other different objects both in metal and clay related to the Ancient History of Roman times, belongs to Mr. Giuseppe Cerchiari. To him Palaeontology owes many discoveries of fossil Bones in our Pliocene Terrains. I am indebted to His kindness and friendship for information about setting of the weapons that I was allowed to keep for a long time, in order to make an exact copy of them by drawing.

The localities in which such weapons were mainly collected in the Imola area are almost all found in the Goccianello Parish, a few miles from the City [of Imola]. It seems that a marge number of them could have been provided by some low Pliocene hills, rising up toward the Apennine [divide] away from the plain. It is desirable, however, to make this observation elsewhere in order to judge whether their occurrence is related to the chance or to a different cause relevant to the History of the same weapons.

The flat portion of our Country in the plain, instead, has delivered very few weapons. I believe this is related to the fact that, in the modern Epoch, the Sea reached the base of the first Apennine hills, covering with waves what is now fertile soil in the plain. Previously, the hills above the sea were the only areas able to be settled [*p. 6 / 261*] because of their salubrious air, which man could enjoy, and the rich forest available.

The terrain does not need to be of any particular composition in order preferentially contain these weapons hidden within, all terrains are eligible provided they represent a modern sediment or a *present formation,* which is the same thing. Thus, at the earth's surface, [weapons] have been always been

observed scattered in farmland. Concerning their history, nothing remarkable has been observed except for one weapon that was found close to small fragments of various types of flint. Such shards are evidence of the place where men of that time made their weapons. This fact has been observed also for some weapons found in France. This is a basic argument that shows that inhabitants of these countries built and used the weapons.

To provide better evidence for those who have never had opportunity to see some of these weapons and [to understand] how difficult their production using evidently very simple tools was, I quote some words by Brard (op. cit.) related to the process implemented by the Ancient Peoples to fulfill their objective….

"one began by selecting a shard favorable to the form and size of the planned tool. It was outlined by major marks, then by very small blows; once the object was no more than finely rugged, one proceeded to polish it; we do not know by which process; what is certain is that the axes or hammers are cut with remarkable precision; their cutting edges are sharp and beautifully curvilinear; their ridges are well felt. Though seconded [p. 7 / 262] by all our procedures and all hard stones available to us for use and polish, it would be difficult for us to produce cherty tools more perfect than those we are examining. … The stony darts whose form is very close to that of iron arrows, have not only tip and barbs, but a sort of small tail serving to secure them to the wood. Such a complex form implied numerous difficulties, but simple inspection of these darts convinces us that they have been cut by percussion and processes analogous to those used today for cutting flint. The sling-stones, and especially the corners, axes, or hammers, whose pyramidal form ends on one side by a garter stitch and on the other by a sharp cutting edge having the outline of part of an ellipse, are small monuments that survived all revolutions. They are available to inform at once the sagacity of savants, antiquaries and artists".

Not all these weapons were made indistinctly from the same [kind of] stone. They were not indiscriminately produces, some in chert, others in Serpentine, Nefrite, etc. Man did not look for a particular mineral species exclusively for that aim, independent of the Country in which he was living. He had always to subjugate his work to the Petrology of that country. Thus, in France we see the Piromaco chert, enclosed into the *Creta* [formation], was preferably used for making darts (a fine task requiring compliant fracturing in the stone employed); instead, for making Axes, the kind of larger weapon needing higher tenacity of their stone to avoid slivering by use, Serpentines, Petrocherts, and Lavas were employed. In the same way those men who [p. 8 / 263], in the past, went on to populate our Countries, necessarily having to submit their arts to the haphazard nature of the soil, were bound to employ these hard stones as the only available [material]. The stones were then shaped to [produce] small or large weapons, depending on how they lent themselves [to fashioning]. Now, which ones were the stones in our soil available and suitable for their aims? Let us have a short overview.

The *Creta* Terrain in terms of mineralogy does not exist here [strictly referring to the Imola study area], thus scattered chert lenses contained elsewhere in it are lacking here. Small beds, crusts and also lenses of some varieties of Quartz-agate are seen to penetrate within calcium sulphate strata of the Gypsum formation (on the age of which I do not want spend time and discuss here) at the Crivellari for example, near Rivola upon Senio, on Monte Mauro, and at Brisighella [all sites south of Imola]. The agates, extremely fine in texture and homogeneous in composition, are very suitable for acquiring the morphology that a well-balanced hammer needs for appropriate hitting. This Quartz sometimes transparent, sometimes matt, is milky in color, or banded ash, dark blonde, rarely containing scattered small casts or molds of fresh-water shells (Cyclostomes, Paludines). A variety of this stone, provoking the Geologist to reflection, is commonly associated with the previous ones (of which it is only a special variation) and consists of an aggregate of many small, white laminae. These variously cross each other, but always with some order, so as to contain well preserved gypsum crystals [together] in an envelope. When the calcium sulphate crystals are

weathered and detached from their matrix, only a frame of chalcedony remains visible, [*p. 9 / 264*] providing almost the idea of a comb, which the French authors called *Quarz carié* [1].

All such types of Quartz detached from their natural sites and rolled down the mountain slopes were transported from terrains and dispersed on our [fluvial] plains, where they certainly existed also in ancient time, and were more easily visible to those who appreciated and were thus looking for them. Therefore almost all the weapons drawn in the attached plate have been produced in the chert types listed above (except for those labeled by a letter and a few others for a specific reason). This is evidence that the Mineralogist can provide to the historian to argue that these weapons were actually manufactured at the same site where they were found today, and by those populations living in Italy in ancient times.

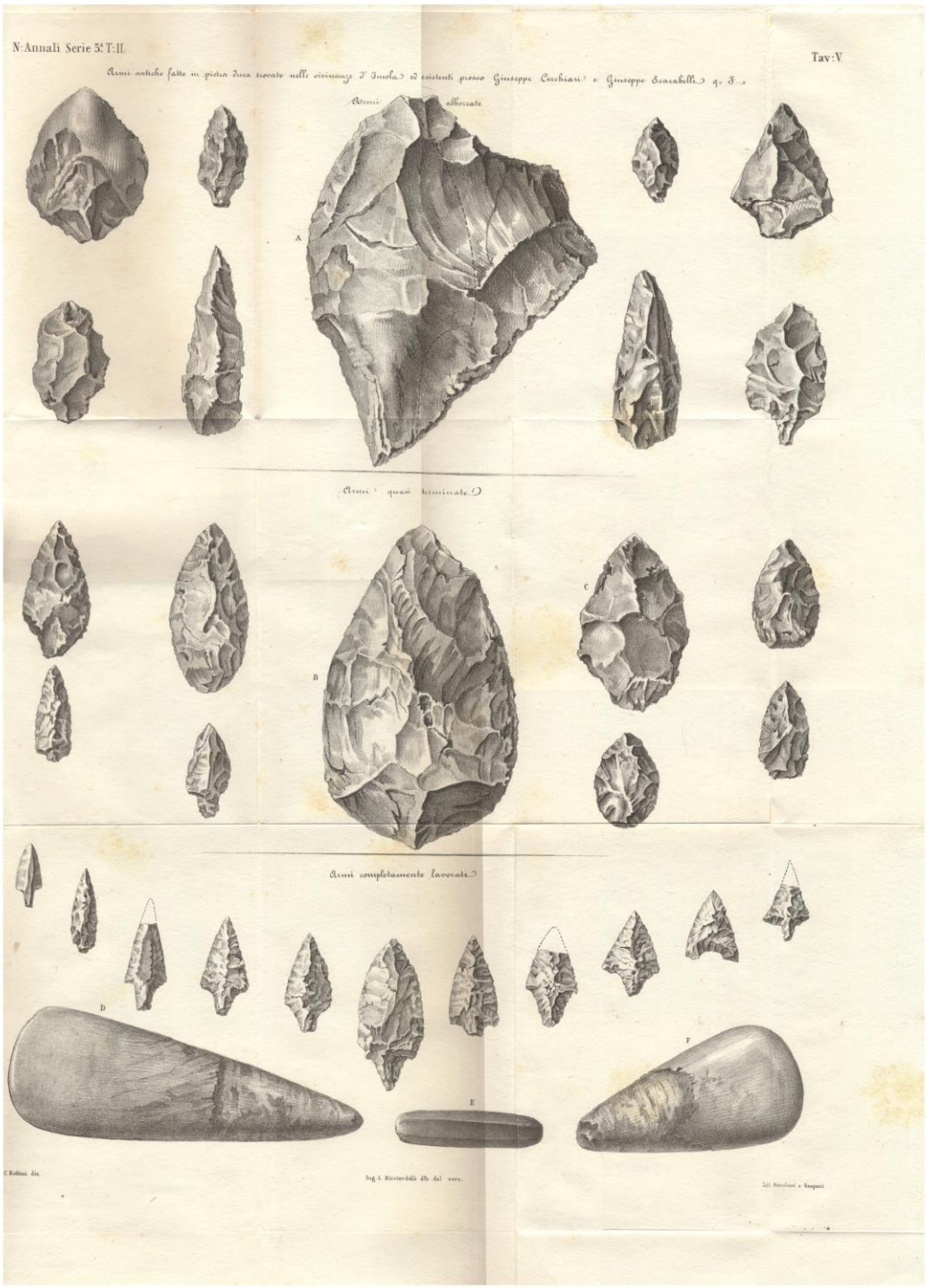
Some other types of chert are found in the Country as erratic pebbles both in the latest Pliocene and in the Quaternary, or Diluvian deposits. Those types suitable for arrow dart, for both the homogeneity of material and for their size, are reddish or yellow in color; in fact, we observe some of these weapons to have been made from similar types of chert. The agate cherts, very beautiful for both transparency and color and which [p. 10 / 265] are commonly collected in the Sub-Apennine Yellow Sands, are generally very small. Therefore the Ancient Men did not use this type of mineral for making their weapons.

It is worth noting here that, in both Tertiary and Diluvian Terrains, some small, rounded siliceous pebbles of various size are found. They are full of many Nummulites, which are sometime microscopic and sometime reach the size of a lentil. These pebbles of dubious source, more probably Alpine rather than Apenninic, can reach the maximum size of an egg, and have a matrix that is not too fine due to the presence of enclosed organic bodies. Exceptions occur when the Nummulites are microscopic. Only the weapon labeled C in Plate V is made by this matter. The weapons A and B are made by coarse-grained black silex, the only type available by us in large samples, which I have very often checked by cutting wood into shapes (Xiloid Quartz). Weapon A could have assumed the form of an arrow for a spear, judging from the shots received. Weapon B probably served as bullet for a slingshot.

As to the Axes, or the *casse-têtes* of French [authors, axe] D is of dark green Serpentine, [axe] E of light green serpentine as is the other small tool E, which is sharp on both sides. I am not able to be sure of the source area of the stone used. This mineral species [Serpentine] is not found as a simple rock among our *Erratic* blocks of Granitic, Porphiric, Euphotid, Ofiolitic, Talcic type.

For the time being, to complete this short report from the Archaeologic view point, it is useful to add that [*p. 11 / 266*] recently, and for the first time, an arrow dart made in Bone was found in one of the localities mentioned above. This manufacture was not perfectly accomplished, and like the [equivalents] made in hard stone, shows evidence of blows received transversally to thin it, through the same hand that, ignoring the use of metals, was forced to make use of some stones that could approximately simulate a hammer.

[1] I hope to obtain another opportunity when speaking of the Gypsum in our country to express my own opinion about the origin of this Quartz, that is the matter enclosing the Calcium sulphate crystals, to be coeval with Gypsum, whereas the quartz concretions containing fresh-water snails to be later and pertain to more recent epoch



Caption to Plate V (from top): Ancient weapons of hard stone, found in the surroundings of Imola and kept by Giuseppe Cerchiari e Giuseppe Scarabelli G.F.
drafted weapons (top), almost finished weapons (middle), fully accomplished weapons (bottom)

Appendix 5

On Quaternary deposits of the Imolese – Improving some opinions about setting of fossil bones. [*Sopra i depositi quaternarj dell'Imolese – Rettifica di alcune opinioni intorno alla giacitura delle ossa fossili. Lettera del sig. G. Scarabelli al ch. Sig. dott. Antonio Toschi*]

Annali Scienze Matematiche e Fisiche, Roma, Gennajo 1852, 3, 33–41, 1852

Dearest Friend,

As a sign of your kind attention toward me, you have already published a letter of mine where I touched on finding sites of fossil Vertebrates bones in the Imola [area] and shared with you my opinion as to their geological position [in the sequence].

Now these opinions have undergone major changes with the increase of my own observations. I thought earlier that such bones were resting within a deposit underlying the Pliocene Sands. At present I am convinced that the bone-rich deposit unconformably overlies the same sands, and therefore is to be referred to the quaternary terrains. However, do not worry that I deal with these deposits in the present letter. I shall mention the position, extent, nature, and represent the relation they have with the underlying Pliocene formation by suitable illustrations. You will be able to appreciate my thoughts on the geologic period to which I believe now need to assign [the bones].

Surely you have observed the following very interesting fact that, to both the West and the South of our City, alluvial deposits of the Santerno [River] (on which Imola indeed sits) is flanked by a raised field, in the form of a terrace. At its top [*p. 4-34*] a plain extends where one could walk for long horizontal distances, unless it where it has been incised by streams, which require you to go down into small valleys almost as deep as the Santerno [R.]. The same happens along the Emilia road, toward both Castel S. Pietro and Castel Bolognese in the opposite side. In fact, both the uphill and downhill [segments] encountered along the road leading to the two towns represent exactly what [I] mentioned above, i.e. a road running at the top or at the base of that raised plain.

The flat fields of Croce in Campo SE of Imola extending to Bergullo and ending up at the Serra hills are part of this terrace or platform, as well as the sunny land of Monte Ricco, Bel Poggio and Monticino to the Western side of the city. This terrace, as an inclined flat[-lying area] that is only slightly raised toward the Apennines, laps onto the Pliocene beds [that are] slightly inclined and trending NW-SE on both sides of the Santerno [R.]. The Pliocene beds form our first hills of Serra, Bergullo, Monte Catone and Dozza.

Looking toward the low plain (formed by modern floods), the high terrace ends sharply in a steep step in all these sites [above] where it has not been smoothed into a gradual slope to the plain by weathering. This step has a mean height of 25 meters, where it is most [well]-developed. It now appears up the Emilia [Road] (Santerno, Correcchio, Pratella), where it is incised and eroded at its base by the various water courses of our territory; it is also clearly visible at the Castellaccio Mount which in the past was also incised by the Santerno waters, and these days is only flanked by the modern alluvial deposits [*p. 5-35*].

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The theoretical section of the country part, running from the Correcchio to the Croce in Campo church and crossing the Santerno R. Fig. 1, shows you the relationship in terms of elevation of the plateau to the modern alluvial deposits better than any detailed description. From my observations, I am able to say that this elevated terrace consists of materials of different rocks grouped into three stages. Each one of the stages was deposited under special geological circumstances which, in some places, occurred in a regularly sequential order each after the other (as seen by the three stages present on the same spot); but sometimes one or the other of the stages is missing in the series; however, their chronologic order is never reversed.

Thus, I believe I can say with some certainty that our Quaternary terrain, entirely referred to as *Apennine Diluvium* from bottom to top, consists of three separate formations: the one I call *gravelly*, another *marshy*, and the last, *fluvial*. These formations are synchronous to the alluvial [deposits] called "*Pliocenico*" by Gastaldi & Martins (Bullettin geologique de France, t. 7, 595) in the Po Valley near Turin, as you will see from the fossils contained and partly for their orictognostic nature. A closer geognostic study of these [Turin] alluvial deposits will possibly prove a perfect synchronism of the bone-rich terrains of the two countries.

Let us deal of the lower formation.

It rests immediately above the yellow sands and occupies precisely the bottom of certain furrows, likely due to erosion by the water currents transporting and depositing the stony elements it consists of. You will see the clearest example of this fact in Fig. 2, which was derived from a slide on the Pratella Creek bank near Mount Castellaccio.

This deposit is exclusively *[p. 6-36*] formed by rolled pebbles, rarely cemented together, and varying both in size and morphology. The largest [pebbles] do not exceed 0.4 m in diameter. Remarkably, the purely siliceous ones are the most regularly rounded, whereas the others show only, at most, smoothed angles. All different Apennine serpentinitic rocks, and those of them metamorphosed into japers, ftanites, spilites, are present in our gravelly Fm. There are pebbles of *alberese* limestone, *macigno* [sandstone], aragonite and nummulite siliceous limestone that was found in Tuscany by Caillaux in the Castellazza mountains, but has not yet been found in situ on our [NE] Apennine slopes. What is really surprising is to find some small but characteristic pebbles of grey granite, garnet-bearing micaschist and porphyric eurite, though very rarely, together with [pebbles] of the diverse collection of rocks [listed above]. The problem arises because their source rocks do not outcrop on our [Apennine] slopes, except perhaps in some older conglomerates. [However], until this fact has been checked, I would be the last to accept the assumption trying to explain how pebbles of this kind arrived to us from the Alps; and if one believes what naturalists are reporting, pebbles of this kind should be observable also in the Pesaro and Sinigallia areas. The abundance of different types of mentioned [exotic] rocks in the rolled pebbles changes depending on the sites, as well as the pebble size. The Bergullo church sits above a conglomerate exclusively formed by small siliceous nummulite pebbles; along the Correcchio [stream] abundant jaspers are visible, serpentinite [pebbles] prevail at Castellaccio [Mount], and the conglomerate at the Sganga is mainly calcareous.

In my other letter I told you that part of the fossil vertebrate bones are found in this deposit (at the Sganga site) and fragments of marine shells plus vegetables are present inside the conglomerate of the same locality. [*p. 7-37*] I shall just say that such fragments of shell, once well studied, all pertain to the yellow

sand formation and have been, indeed, weathered during the deposition of our pebbles. A mixture of fossils of the two formations must certainly have occurred under the circumstances.

This deposit does not exceed 2 m in thickness and appears to consist of only one bed.

The second stage of the quaternary terrain, I referred to as *marshy* formation, rests above the previous one (Fig. 2), except where it was deposited directly on the yellow sands lacking the *gravelly* Fm. The [marshy] deposit is very thick and its various beds reach a total mean value of 5 m. It is formed of a poorly stratified yellowish blue, red ochre mudstone (a true *Lehm*); sometimes a yellow sand almost indistinguishable from that of the Pliocene [fm.] or, lastly, a very fine, mainly siliceous breccia present in this formation. The main characteristic feature of these deposits is the presence of whole terrestrial snails (Cyclostomes) mixed with usual fragments of marine shells in some sites (Castellaccio); in other sites it is the presence of marshy shells (Anodonts) or plant impressions (Pratella Creek near Sganga); or, lastly, the abundance of granular iron hydrate near Bel Poggio.

In sites where our marshy formation consists of more clayey *Lehm*, one sees those very white calcareous concretions commonly exposed in similar deposits of Piedmont, the Rhein valley, and at Sganga. Here, where a part of this formation is a bit sandy, many fossil bones have also been dug out. Among others, in 1850 our common friend Giuseppe Cerchiari discovered a good part of a Rhinoceros skeleton at this site, i.e.:

Atlas or first cervical vertebra [*p. 8-39*]
two cervical intermediate vertebras
7th cervical vertebra
1st dorsal vertebra
6th dorsal intermediate vertebra
15 badly preserved vertebra from different regions
2 caudal vertebras
various kinds of spiny apophyses
a possibly Isk bone fragment
same of Humerus
various rib fragments
2 foot bones
Also those 12 upper molar teeth found in the same place in 1842 pertain to the same individual.

All these bones I have accurately compared with drawings of the corresponding bones reported in Blainville's Osteology work and found bones *totally identical* to those referred by [this] author to the African Rhinoceros (Rhinoceros bicornis).

If you want to know precisely whether other vertebrate species were found in the marshy or in the other gravelly and older formation, so as to obtain palaeontological inferences on the chronologic appearance order of different animal species in the two formations, I cannot satisfy you. In fact, other bones of Elephas, Hippopotamus, Horse, Deer etc. collected in these places have been found in settings that are poorly suitable to solve such questions.

The third formation I called fluvial rests on the previous two (Fig. 1) and also on the first when the *Lehm* is missing. It is mostly made of rounded pebbles of limestone, "macigno", "molassa". The pebbles always outcrop as loose gravel, similar to that transported today by the Santerno [River], except for the slightly ferruginous colour of the earth mixed with them. This [*p. 9-39*] deposit is 3 meters thick; its pebbles have much smaller size than those mentioned in the lower formation, a rounder form, and provide very few samples of the cherty and extrusive rocks which appear in great amounts in the lower formation.

No other fossil seems to have been ever found in this [3 m thick] gravel, except for some horse or ox teeth. It is therefore possible to infer that, since the time of its deposition, the great pachyderms no longer lived in these Countries.

Let us consider now the extent of the country occupying our quaternary terrain. Here the degree of elevation attained at the beginning, and the conical geometry affecting it as a whole, draping on the Santerno valley, was incised at a later [period] inside the same valley, and then widened and almost merged with the *modern* plane. Thus, we are obliged to consider as our quaternary deposit what remains of the *depositional fan* that all high-velocity water courses created at their mouths. In the same way, the Santerno [R.] formed a similar *cone* with the material derived from the Apennines when it began to cut the not yet peneplaned crests of our Pliocene hills. In fact, steeper slopes of the river in earlier times is attested by the pebbles of greater volume that we observe in the first gravelly formation of quaternary T.[ime], which never occur in the succeeding [formations]. If you ask me about these pebbles, the explanation of which I already mentioned above, that serpentinite, jasper, spilite pebbles are abundant in the lower formation and rare or lacking in the upper ones, I consider this fact not to be a problem requiring some strange scientific assumption, but rather an occurrence totally inherent to the secular life of rivers. This is due to the different degree of specific degradability of the rocks. *The long denudation operated by any water course in the terrains it cuts through must progressively increase the amount of more degradable as well as of the more abundant material inside the deposits produced by it as a function of time* [*p. 10-40*]. Let me explain.

Imagine for example the Santerno [R.] transporting in ancient times in a given place an amount 2 of crystalline rocky material and 6 of the sedimentary rocks common in our locality. If, after many centuries, one was to observe which rock the river had accumulated in that place, I believe that proportion between the pebbles would be changed, the number of those sedimentary rocks referred to, which are dominant here and by nature and particular geological circumstances are easier to degrade, being increased. Which are the types of rocks easy degradable and occupying greater areas on our [Apennine] slopes? I don't need to remind you of the country we live in, they are sandstones, different types of molasse, hard and marly limestones, which form all this part of the Apennines where only exceptional eruptions of serpentinite occur, accompanied by a few species of related contact metamorphic rocks. Thus, in conclusion, the difference in composition we find between older and more recent deposits does not depend on a lower amount of pebbles of some of those rocks transported by the Santerno [R.]. It rather depends on the increased proportion of other rocks [and derived pebbles] in the upper formation. This, at first sight, would suggest that the circumstances under which deposits originated in different times had changed.

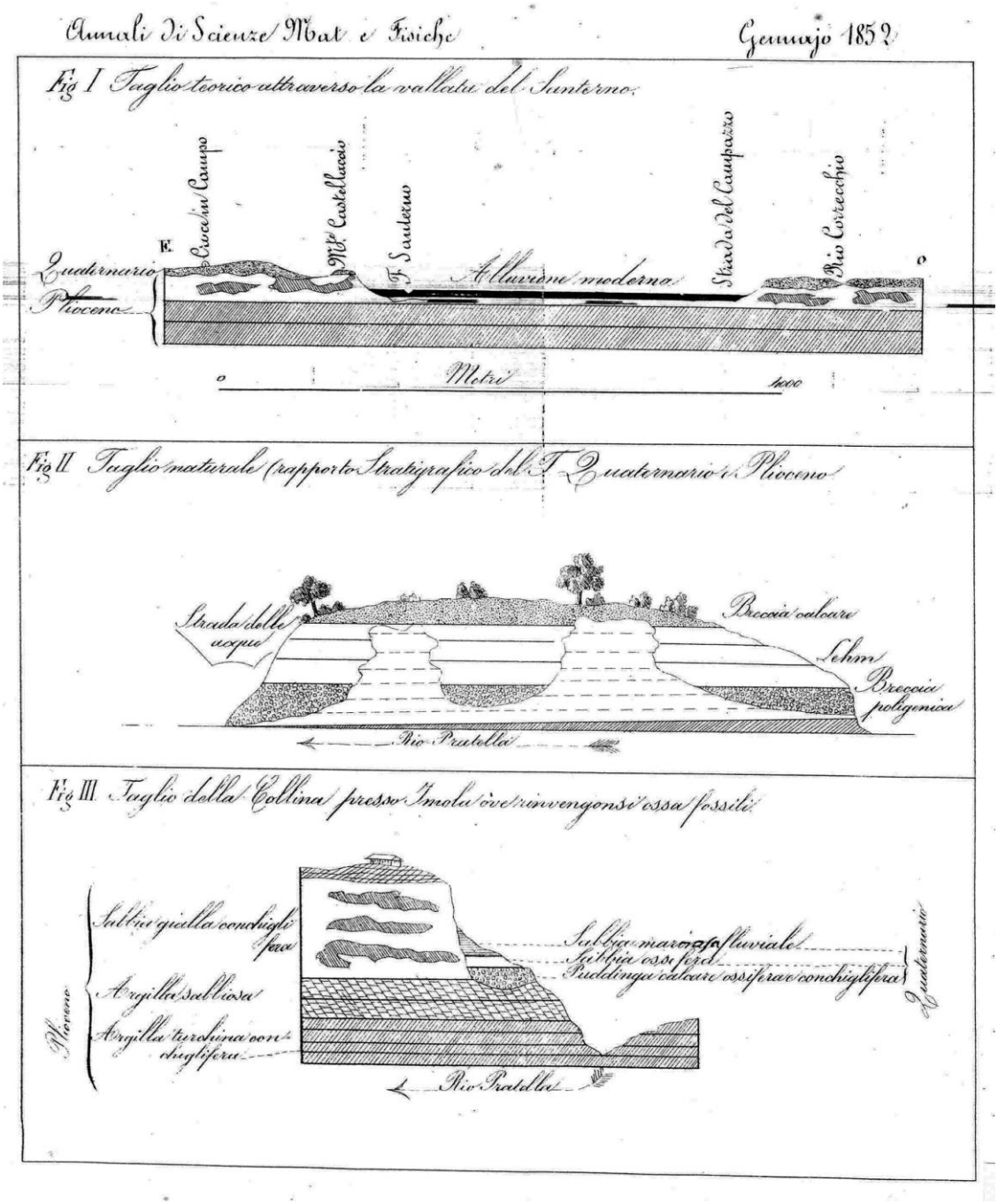
In this way I have shown you that our quaternary terrain consisting of three different formations appears to us as the result of the alluvial fan made by the Santerno [R.] in other time and extending unconformably over the yellow sands. Its deposits cannot be confused with those of the present period because they [occur] at a much higher level and are characterized by fossil bones. I have only to apologize to have bored you too long perhaps with this letter, and take the opportunity to declare me with whole mind

Affectionate friend G. SCARABELLI

Imola 9 september 1851

P.[ost] S.[criptum] Fig. 3 at the end of the attached Plate shows you immediately the amendments to make in the similar figure attached to my previous letter on this topic. The corrections change substantially the geognostic position of the bone-rich terrains in respect to the Pliocene ones. You will also appreciate that no love of a system but observation mistake did guide me in tracing that drawing. This last figure [3] wholly

corresponds to the two preceding it in the plate and is consistent to what I tried to expound in the clearest way I could in the present [letter].



Geological sections across the bone and cherty tool bearing deposits in the Imolese area (next to p. 11-41). From top:

Fig. I Theorical EW section across the Santerno Valley (Pliocene formed by blue clay and superposed yellow sand unconformably followed by Quaternary formations on top of both tracts of the higher terrace and modern alluvial deposits in the interspaced lower plain)

Fig. II Natural section along the Pratella Creek (stratigraphic relation of Quaternary Terrain (polygenic Breccia, Lehm, calcareous Breccia) to the Pliocene [deposits]

Fig. III Section across the hill along the Pratella Creek near Imola where fossil bones have been found. The Pliocene column is to the left (blue shell-bearing clay, sandy clay, shell-bearing yellow sand); the Quaternary column, unconformably overlying the Pliocene deposits, is to the right (bone- and shell-bearing calcareous conglomerate, bone-bearing sand, fluvial marly sand)